FUNCTIONAL OUTCOME ANALYSIS OF FIXATION OF DISTAL RADIUS FRACTURES USING 'FIVE PIN TECHNIQUE'

Dissertation submitted to

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M.S Degree Branch-II

Orthopaedic surgery

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CERTIFICATE

This is to certify that this dissertation titled **FUNCTIONAL OUTCOME ANALYSIS OF FIXATION OF DISTAL RADIUS FRACTURES USING 'FIVE PIN TECHNIQUE'** is a bonafide record of work done by DR.JERRY SAM during the period of his post graduate study from June 2014 to June 2017 under guidance and supervision in the INSTITUTE OF ORTHOPAEDICS AND TRAUMATOLOGY, Madras Medical College and Rajiv Gandhi Government General Hospital, Chennai-600003, in partial fulfillment of the requirement for M.S.ORTHOPAEDIC SURGERY degree Examination of The Tamilnadu Dr. M.G.R. Medical University to be held in April 2017.

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DECLARATION

I declare that the dissertation entitled **FUNCTIONAL OUTCOME ANALYSIS OF FIXATION OF DISTAL RADIUS FRACTURES USING 'FIVE PIN TECHNIQUE'** submitted by me for the degree of M. S. is the record work carried out by me during the period of March 2016 to September 2016 under the guidance of Prof. V.Singaravadivelu M.S.Ortho, D. Ortho., Ph.D., Professor of Orthopaedics, Institute of Orthopaedics and traumatology, Madras Medical College, Chennai. This dissertation is submitted to the Tamilnadu Dr.M.G.R. Medical University, Chennai, in partial fulfilment of the University regulations for the award of degree of M.S. ORTHOPAEDICS (BRANCH-II) examination to be held in April 2017.

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INDEX

Introduction

Distal radius fractures are the most common fractures of the upper extremity seen in clinical practice and encompass about 17 % of all fractures[1,2]. Older women with osteoporosis are the most commonly affected population.

The commonest mode of injury is a fall on outstretched hand although it is not uncommon in high-energy trauma patients. The pattern of injury however was a result of position of the hand, the quality of bone, the surface it makes impact with and the velocity of injury [3] . The injuries associated with distal radius fractures are to the triangular fibrocartilage complex (TFCC) and to the interosseous carpal ligaments. Chondral lesions may also occur and predispose to arthritic changes [4].

Closed reduction and casting has been the most commonly employed treatment modality but the subsequent malunion and distal radio-ulnar joint subluxation results in poor radiological and functional outcomes. Thus, the residual malalignment affects the movements occurring at the wrist joint and distal radioulnar joint. As a result of arthritis of the radiocarpal and distal radio-ulnar joints pain, decreased range of movements and decreased grip strength are commonly encountered problems [5].

Although many treatment modalities are available there is no consensus on the optimum treatment of these injuries. Moreover, radiological parameters of reduction do not coincide accurately with functional outcome.

The most important radiological factors that dictate outcome are:

1. Radial height
2. Ulnar variance
3. Palmar tilt
4. Carpal alignment
5. Articular alignment

Hence, restoration of these radiological parameters is among the only modifiable factors in determining the eventual outcome of these injuries.

Closed reduction and percutaneous pinning is one of the standard treatments for management of distal radius fractures and its modification ‘The five pin technique’ improves the reliability of fixation thus combining the advantages of non-invasiveness as in casting and stability achieved comparable to open reduction and plating.

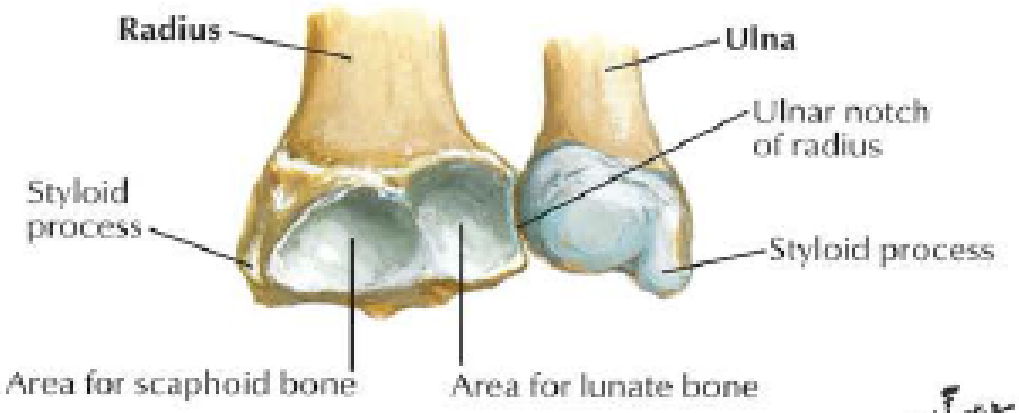
Aim of the study

To assess the clinical and functional outcome of fixation of distal radius fractures using the five pin technique in twenty patients managed in our Institute of Orthopaedics and Traumatology, Madras Medical College and Rajiv Gandhi Government General Hospital over a period of 1 year from July 2015 to July 2016 retrospectively and prospectively.

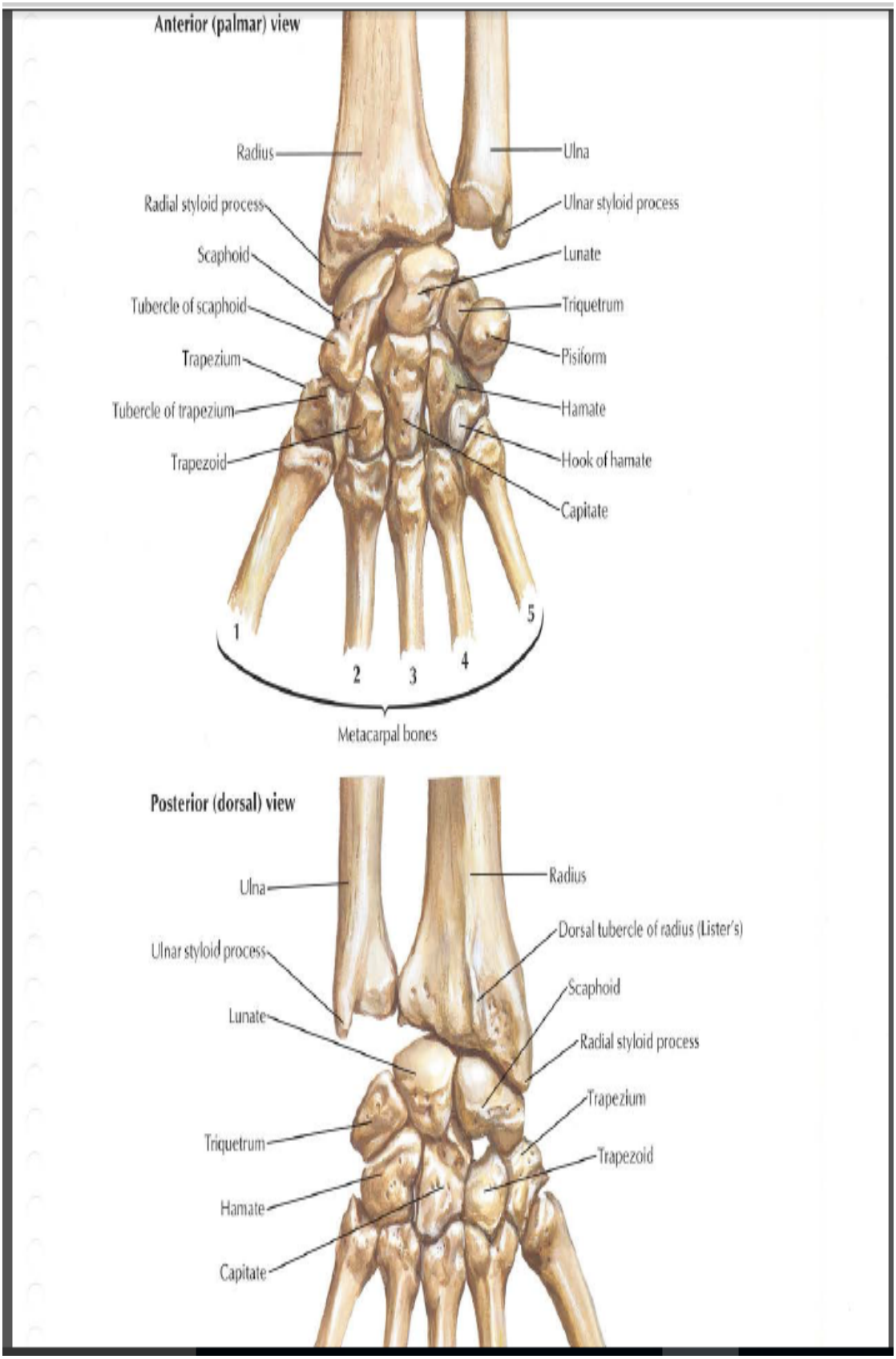
Applied anatomy

The wrist joint or radiocarpal joint is a biaxial synovial joint comprising of the articulation between the distal concave ellipsoid surface of the radius and the convex surfaces of the scaphoid, lunate and triquetral bones. The distal radius has a triangular facet with the apex being the styloid process which articulates with the scaphoid, the rectangular area adjacent to it articulates with the lunate and the triquetral articulates with the joint capsule and is strengthened by the ulnar collateral ligament.

The volar surface of the distal radius is concave from proximal to distal and gives attachment to radiocarpal ligaments which prevents the carpus from sliding in a palmar and ulnar direction. The dorsal surface of the distal radius is convex and irregular with the Lister's tubercle, around which the extensor pollices longus (EPL) tendon passes.



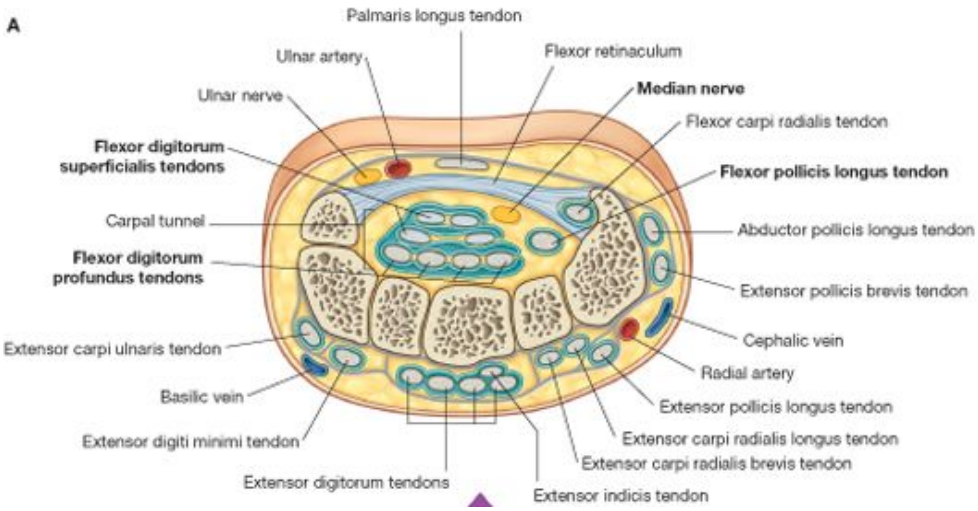
Carpal articular suface


Anterior (palmar) view
Radius
Ulna
Radial styloid process
Ulnar styloid process
Scaphoid
Lunate
Tubercle of scaphoid
Triquetrum
Trapezium
Pisiform
Tubercle of trapezium
Hamate
Trapezoid
Hook of hamate
Capitate
1
2
3
4
5
Metacarpal bones
Posterior (dorsal) view
Ulna
Radius
Dorsal tubercle of radius (Lister's)
Ulnar styloid process
Scaphoid
Lunate
Radial styloid process
Trapezium
Triquetrum
Trapezoid
Hamate
Capitate

The distal radioulnar joint is a uniaxial pivot synovial joint between the sigmoid notch on the distal radius and the convex head of the ulna. A triangular fibrocartilaginous disc is attached by its base to the sigmoid notch of the distal radius and by its apex to the base of the ulna styloid.

The carpal tunnel is formed on the volar aspect of the wrist by an arch formed by the flexor retinaculum with the carpal bones. The base of the arch is formed medially by the hook of hamate and pisiform and laterally by the scaphoid and trapezium.

The flexor retinaculum is a ligamentous thick connective tissue that bridges the lateral and medial sides of the base of the arch and forms the carpal tunnel.

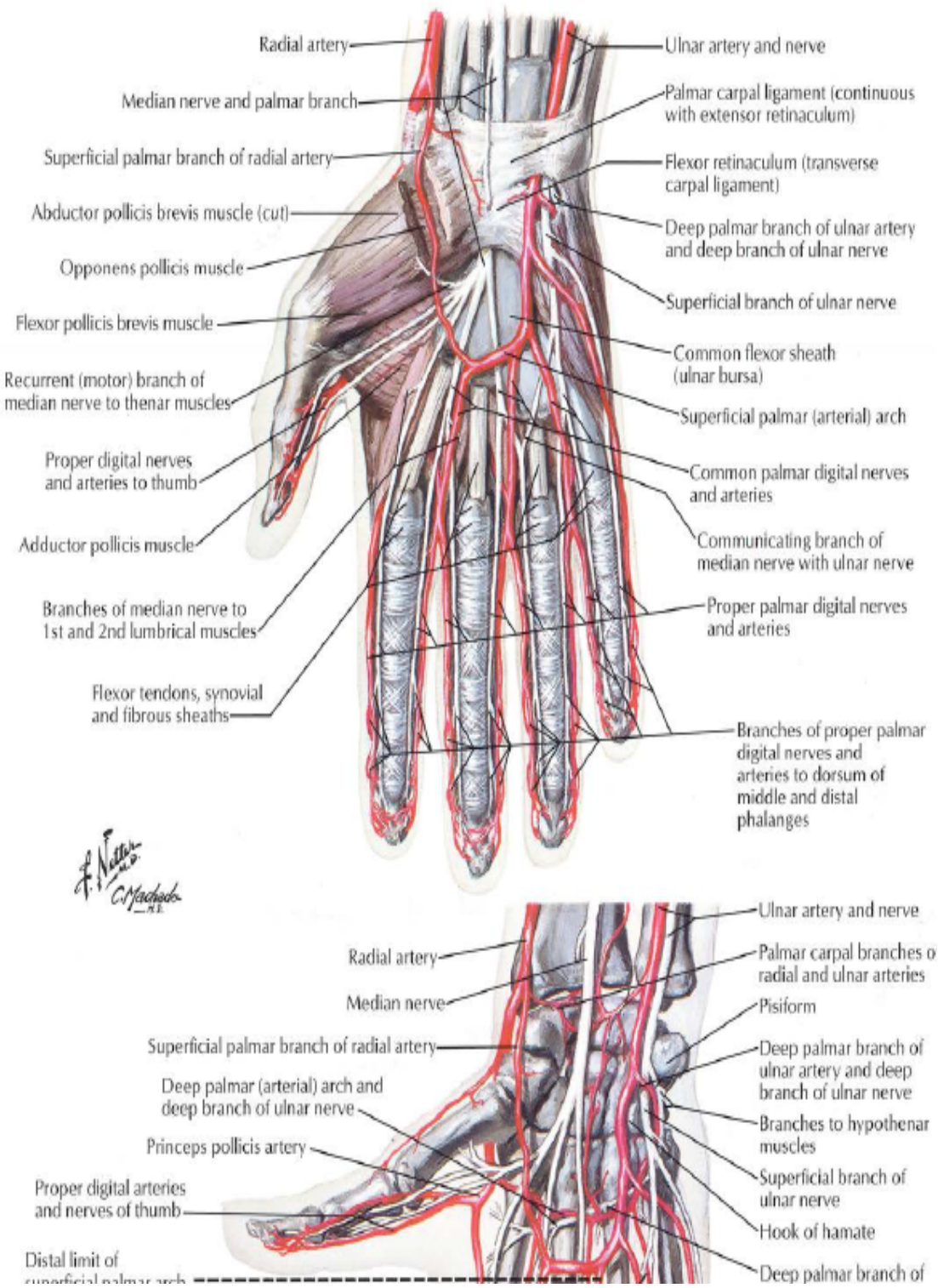


The four tendons of the flexor digitorum superficialis, the flexor digitorum profundus and the tendon of the flexor pollicis longus pass through the carpal tunnel, along with the median nerve .

Neurovascular anatomy

The radial artery in the distal forearm lies lateral to the flexor carpi radialis tendon and anterior to the distal end of radius and the pronator quadratus tendon after which it passes dorsally into the hand via the anatomic snuff box. The ulnar nerve and artery pass superficial to the flexor retinaculum underneath the flexor carpi ulnaris tendon. The median nerve lies between the tendons of palmaris longus and flexor carpi radialis and passes deep to the flexor retinaculum. The superficial radial nerve courses from beneath the brachioradialis tendon and dorsal to the wrist joint before it passes to the hand.

Neurovascular anatomy



Review of literature

Distal radius fractures have been a subject of ongoing discussion for over two hundred years. The fracture patterns of the distal radius were studied before the luxury of radiography. Ponteau [6], a French surgeon described the fracture pattern earlier but, Abraham Colles [7] is widely credited for the description of the most common type of distal radius fracture.

In 1854, Smith [8] claimed that a fall on the back of a flexed wrist results in palmar displaced distal radius fractures.

In 1915, Jones [9] described closed manipulation and reduction by exaggerating the deformity ,traction and maintaining the wrist and hand in reduced position.

In 1929, Bohler [10] suggested a gravity assisted passive method of reduction of distal radius fractures.

In 1950, Charnley [11] et al published the traditional casting technique which involves three point moulding using three pressure areas over the distal forearm, distal fragment and proximal fragment.

In 1967, Frykman [12] claimed that when a fall occurs with wrist in 40-90 degrees of dorsiflexion a distal radius fracture occurs with dorsal

displacement and also classified fractures based on presence or absence of intra-articular extension into either or both radiocarpal and distal radioulnar joints.

In 1975, Sarmiento [13] suggested immobilisation in supination to hold the disrupted distal radioulnar joint in reduced position.

In 1984, Melone [14] concluded that radiocarpal joint comprised of four components and intra articular fractures occurred in five basic patterns.

In 1990, Bartosh and Saldana [15] concluded that no method of closed reduction can accurately restore palmar tilt as the thicker vertically oriented palmar ligaments are stretched out to length before the thinner Z-shaped dorsal ligaments.

In 1995, Connolly [16] described fracture reduction by reversal of mechanism of injury.

In 1908, Lambotte [17] described a single pin placement from the radial styloid to stabilise the distal radius fracture.

In 1976, Kapandji [18] first described the intrafocal pinning with two pins. Fractures with articular displacement and volar comminution were reported contraindications.

In 1989 and 1991, John M. Rayhack [19] described the ulnar-radial pinning for stabilisation of distal radio-ulnar joint after reduction by ligamentotaxis and manipulation of distal fragment. However, Smith fracture with volar comminution is a contraindication.

In 1996, Rikkli et al [20] claimed that the wrist consists of three columns namely the lateral, medial and the intermediate column of which the intermediate column is considered the cornerstone.

In 1987, Weber [21] reported that distal radius fractures occurring with low loading angles (20-40 degrees) are minimally comminuted and those occurring with high loading angles (70-90 degrees) are highly comminuted. Loading angles greater than 90 degrees result in carpal injuries.

Ligamentotaxis vs K-wire fixation

In 2010 Ashok K Shyam et al [22] studied 65 comminuted distal radius fractures and compared the outcome with K-wire fixation and ligamentotaxis. They concluded that though pin tract infection had a higher incidence in the external fixator group both methods worked well with good clinical and functional outcomes.

Volar plate vs K-wire fixation

In 2015, Shuang-Le Zong et al [23] in a meta-analysis for dorsally displaced fractures comparing the volar locking plate and Kirschner wire fixation concluded that the DASH scores although significantly different at 3 and 6 months post-operatively, at 1 year were comparable.

In 2015, Brennan et al [24] concluded that although the volar plate resulted in a radiological outcome that was superior, it did not translate into a better functional outcome.

In 2015, Tubeuf et al [25] concluded from the Distal radius acute fracture fixation trial (DRAFFT) that compared to the volar locking plate , K-wire fixation is a cost saving intervention and has similar health benefits.

Mechanism of injury

The fracture is caused by a fall on outstretched hand. The thenar eminence takes the majority of the force. The fracture of the distal radius occurs while the triangular fibro-cartilage is still intact, hence there is a rotatory component with the centre being the ulna styloid and the distal radius rotates into supination. However, if the force continues the ulna styloid sustains an avulsion fracture.

Six deformities occur which are impaction, lateral displacement, lateral rotation, dorsal displacement, dorsal rotation and supination.

Mechanism of injury

Associated injuries

1) Triangular fibrocartilage complex injury (TFCC) injury

TFCC injury is reported in 39-82% of cases of which the majority of lesions are peripheral avulsions and may be associated with an ulna styloid fracture [26].

2) Interosseous ligament injury

Scapholunate and lunotriquetral are the predominant interosseous ligament injury associated with distal radius fractures [27,28]. The severity of these ligamentous injuries have been graded 1-4 arthroscopically by Geissler:

Grade 1- Least severe with haemorrhage or attenuation

Grade 2 & 3- Increasing ligamentous incongruity

Grade 4- Gross instability which allows passage of an arthroscope from the radiocarpal to the midcarpal joints.

Radiological Evaluation

The series of standard posteroanterior (PA), lateral, and oblique radiographic views is used to visualize a distal radius fracture. Additional x-ray views may be taken as and when needed to assess for additional injuries or displacement.

To quantify the orientation of the distal radius a number of radiologic measurements are used commonly and thus it is crucial to understand these to avoid inter observer error. A significant discrepancy in inter and intra observer reliability has been noticed in the measurements of standard radiographic criterion.

1) Dorsal/palmar tilt:

A line is drawn to connect the most distal points on the dorsal and volar lips on a true lateral x-ray of the distal radius. The palmar or dorsal tilt is the angle formed with a line along the longitudinal axis of distal radius.

2) Radial length:

This parameter is measured on the postero-anterior x-ray. A line is drawn which is tangential to the most distal point of the ulnar head and perpendicular to long axis of the radius and a line drawn at the level of tip

of the radial styloid and perpendicular to long axis of the radius and the distance between them is the radial length.

3) Ulnar variance

It is a measure of the amount of radial shortening and not the measurement of radial length. A line is drawn parallel to medial end of the articular surface of the distal radius and a line parallel to the distal most point of the ulnar head articular surface, both the lines being perpendicular to long axis of radius and the vertical distance between them is the ulnar variance.

4) Radial inclination:

On the postero-anterior view the distal radius is inclined toward the ulna. An angle between the line drawn from the medial corner of the radius articular surface to the tip of the radial styloid and a perpendicular line drawn to long axis of radius.

5) Carpal malalignment:

Two types of carpal malalignment are generally associated with fractures of distal radius. The commonest is the malalignment which compensates for the

distal radius tilt and is thus extrinsic to the carpus. On a lateral view

one line is drawn along the long axis of the radius and one drawn along the long axis of the capitate . The lines will intersect within the carpus if the carpus is aligned. If not, then they will intersect outside the carpus. Associated carpal ligament disruption can also be the cause of carpal malalignment.

6) Anteroposterior (AP) distance and teardrop angle:

The U-shaped outline of the volar rim on the lunate facet is referred to as the teardrop of distal radius articular surface. The angle between central axis of the shaft of radius and the central axis of the teardrop is referred to as the teardrop angle. A displacement of the lunate facet should be suspected when a depression of teardrop angle to less than 45 degrees is noticed [29].

The anteroposterior distance is another measure of articular incongruity and is the distance between the apices of dorsal and volar rims of lunate facet of distal radius. The average normal AP distance is 19 mm on true lateral view, but is best assessed by contralateral normal wrist comparison.

However, specific features must be assessed on each radiographic view of the distal radius as described below:

PA View

For extra-articular fractures :

1) Radial length and ulnar variance

2) Extent of comminution in metaphyseal region

3) Presence of ulnar styloid fracture (tip/waist/base)

In addition, for intra-articular fractures assess the following:

4) Presence and orientation of articular fractures

5) Depression of the lunate facet

6) Gap between scaphoid and lunate facet

7) Central impaction fragments

8) Carpal bone assessment—Gilula's carpal arc 1 or evidence of a scaphoid fracture

Lateral View

For extra-articular fractures assess the following:

1) Dorsal/palmar tilt

2) Extent of metaphyseal comminution

3) Carpal alignment

4) Displacement of the volar cortex

5) Position of the DRUJ

For intra-articular fractures assess the following:

6) Depression of the palmar lunate facet

7) Depression of the central fragment

8) Gap between palmar and dorsal fragments

9) Scapholunate angle for possible associated carpal injury

10) Teardrop angle

11)AP distance

Oblique Views

The pronated oblique view shows the radial side of the distal radius and is useful for assessing the radial comminution and a depression or split of the radial styloid.

The supinated oblique view shows the ulnar side of the distal radius and is particularly useful for assessing the depression of the dorsal lunate facet [30].

Tilted Lateral View

This is also a lateral view taken with a pad kept under the hand to incline the radius 22 degrees towards the beam. It shows a tangential view of the lunate facet and an accurate assessment of lunate facet depression is made possible [31].

Traction Views (AP and Lateral)

These radiographic views are taken with finger traps or manual traction applied after reduction and under anesthesia. They are most useful for planning in articular fractures whether closed reduction techniques will be sufficient or open reduction will be necessary for achieving anatomic acceptable reduction.

Contralateral Wrist (AP and Lateral) views

These x-rays may be indicated for assessment of the patient's normal ulnar variance, scapho-lunate angle, and anteroposterior distance, as it varies between patients.

Radiological Parameters

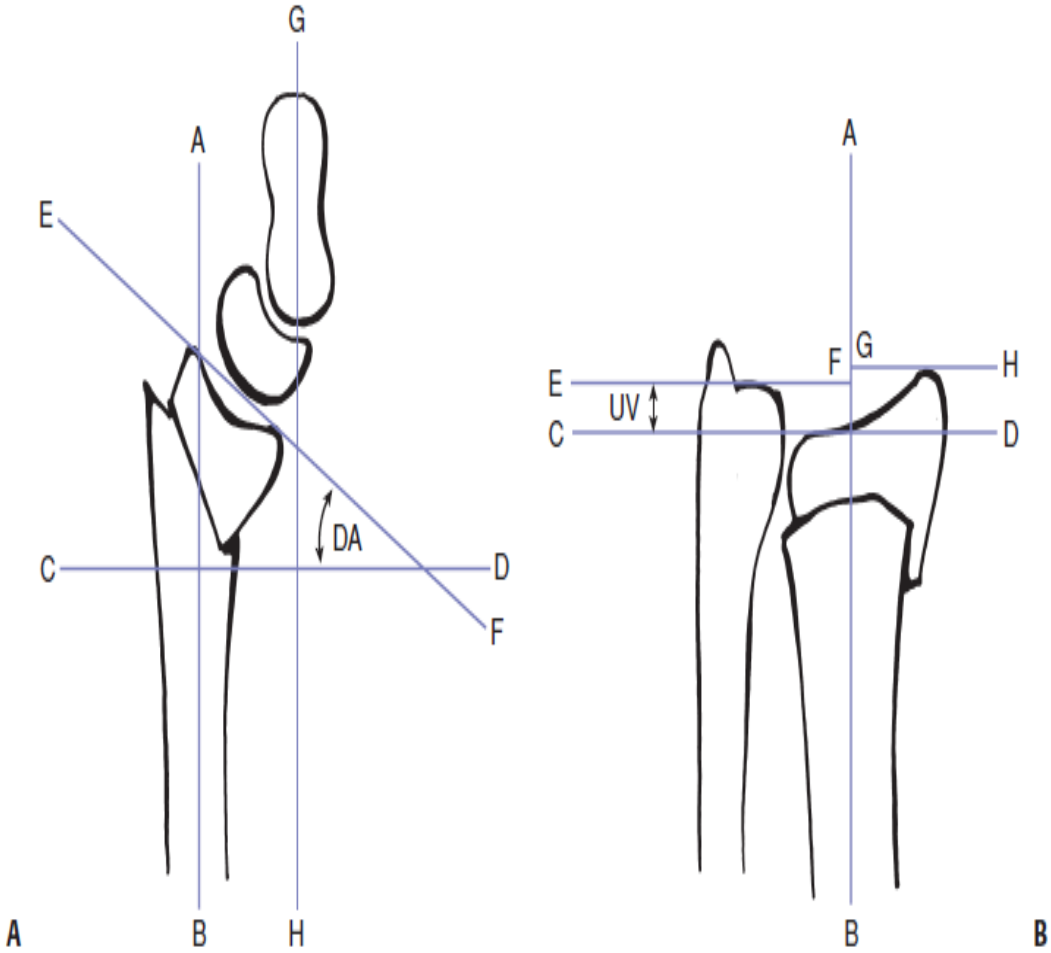


FIGURE 32-3 **A:** The dorsal angle *(DA)* is measured by finding the angle between a line (CD) perpendicular to the long axis of the radius (AB) and a line joining the dorsal and volar extremities of the radiocarpal joint (EF). Carpal alignment is assessed by the point of intersection of the line parallel to the long axis of the radius (AB) and a line parallel to the long axis of the capitate (GH). If these intersect outwith the carpus or do not intersect as in this illustration, then the carpus is malaligned. **B:** Ulnar variance (*UV*) is the distance between two lines perpendicular to the long axis of the radius (AB). The first is tangential to the ulnar corner of the radius (CD) and the second tangential to the ulnar head (EF). Radial length is the distance between line EF and a line tangential to the radial styloid (GH). (From

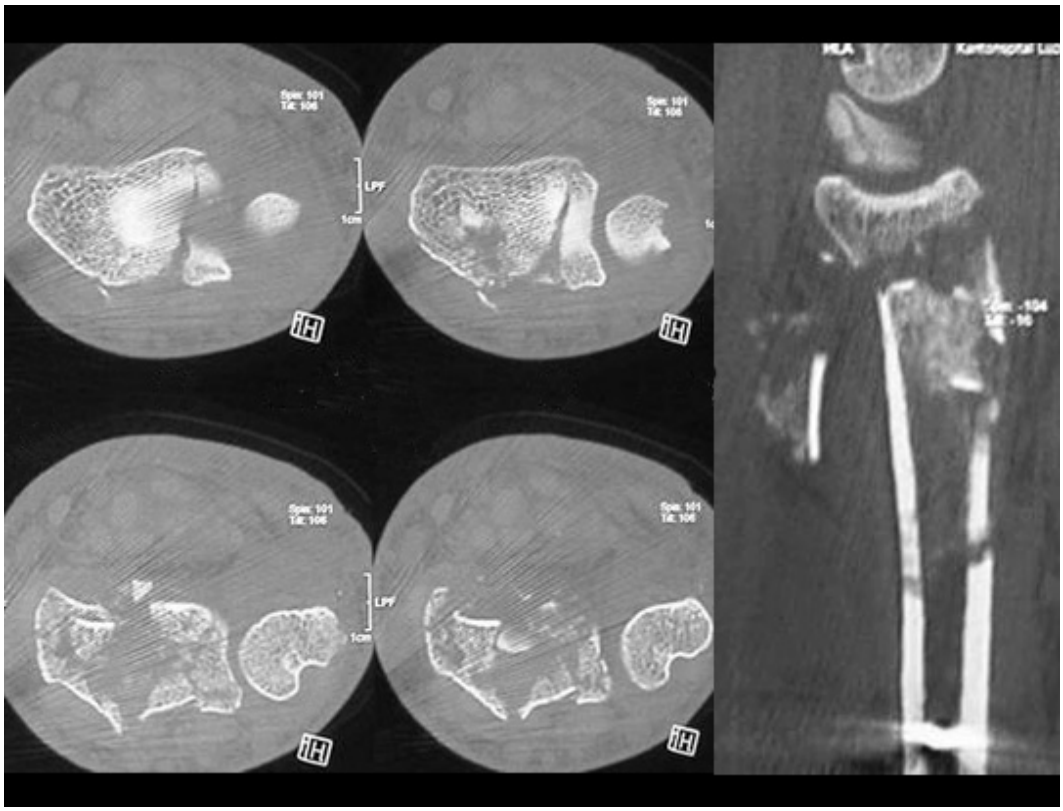
Computerized Tomography

Computerized tomography (CT) scanning is used for better visualisation and the accurate measurement of intra-articular fractures of the distal radius. Literature suggest that CT shows intra-articular fracture lines and displacement more accurately than plain x-rays, particulary shows the presence and displacement of the sigmoid notch fractures more accurately than plain x-rays[32].

Three-dimensional CT scans are now in vogue to assess intra-articular fractures of distal radius. Their use has been shown to better intraobserver but not interobserver reliability and to allow a reliable determination of fracture morphology which may influence management as in coronal fractures, central articular depression and intra-articular comminution.

However, this had led to an increase in the perceived need for an open reduction of displaced articular fracture segments when compared to the conventional CT but the effect of this on functional outcome is yet to be determined.

CT-Scan Image



Classifications

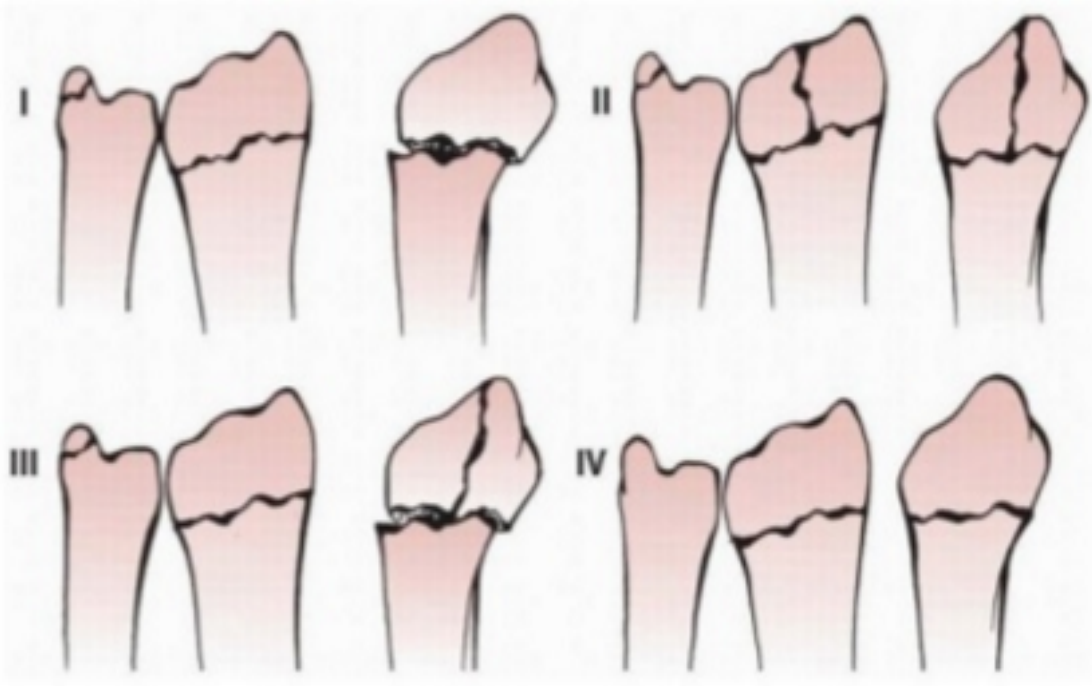
Gartland and Werley [33]

Type I- A simple Colles fracture without involvement of articular surface.

Type II-A comminuted Colles fracture with an undisplaced fracture of the radial articular surface.

Type III- A comminuted Colles fracture with a displaced fracture of the radial articular surface.

Type IV-Extra-articular undisplaced fractures added by Sogaard.



Frykman [34]

Type I- Extra-articular without ulna fracture

Type II- Extra-articular with ulna fracture

Type III- Intra-articular radiocarpal without ulna fracture

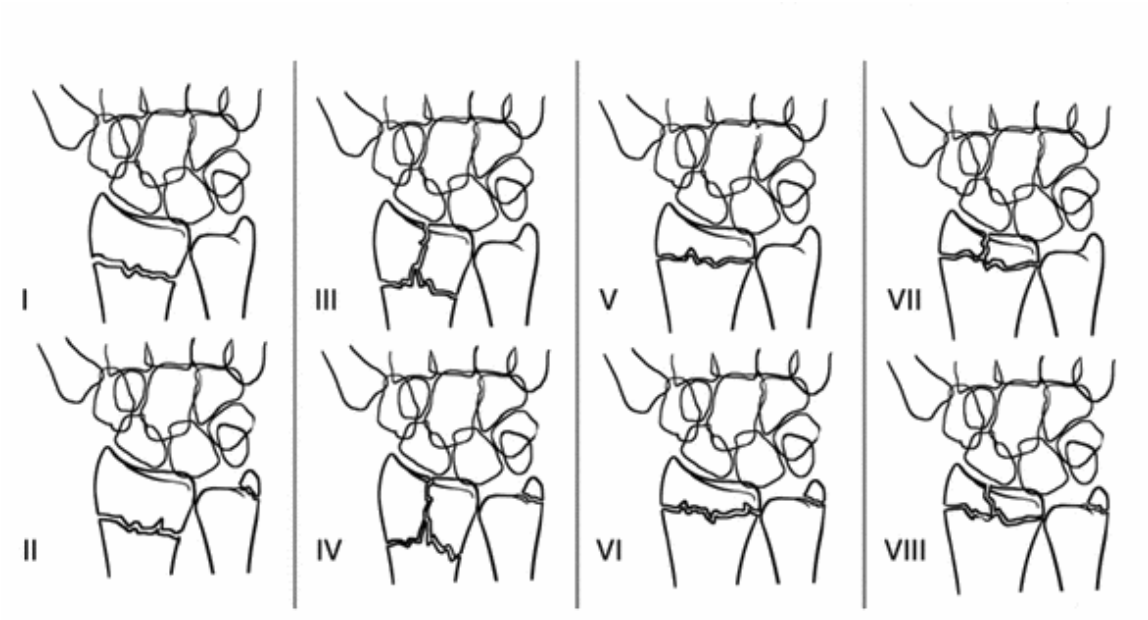
Type IV- Intra-articular radiocarpal with ulna fracture

Type V- Intra-articular DRUJ without ulna fracture

Type VI- Intra-articular DRUJ with ulna fracture

Type VII- Intra-articular radiocarpal and DRUJ without ulna fracture

Type VIII- Intra-articular radiocarpal and DRUJ with ulna fracture



Melone [35]

Type I- Undisplaced or with variable displacement of the medial complex without comminution.

Type II- Unstable die-punch fracture. Moderate to severe displacement of the medial complex with comminution.

A- Closed and irreducible

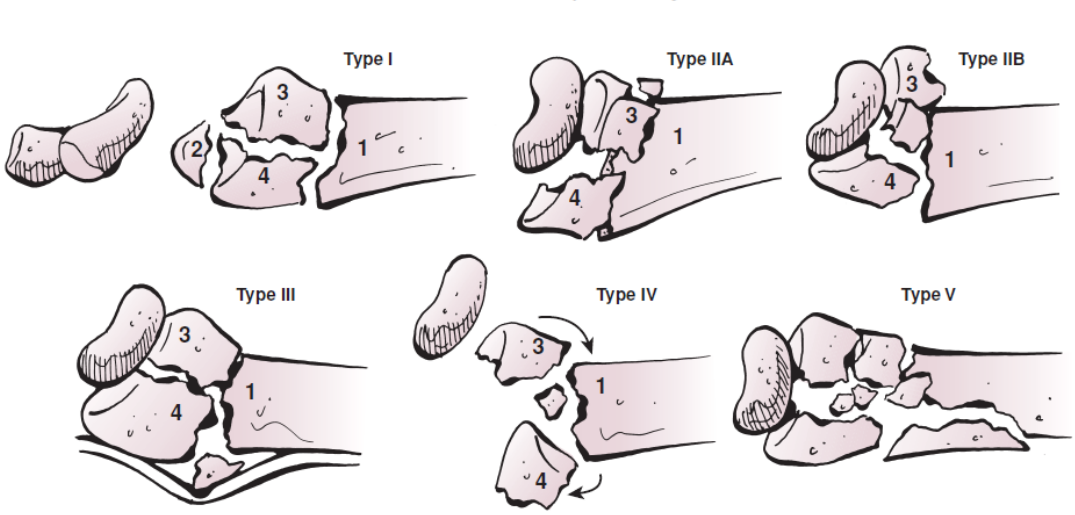
B- Closed and irreducible because of impaction

Type III- As with type II but with a volar spike that might compromise the median nerve.

Type IV- Unstable split fracture with severe comminution and rotation of medial complex fragments.

Type V- Explosion injury with severe comminution and displacement with diaphyseal comminution.

Melone classification



Fernandez classification [36]

Type I- The DRUJ is clinically congruous and stable which includes fracture at the base of ulna styloid and stable ulna neck fractures.

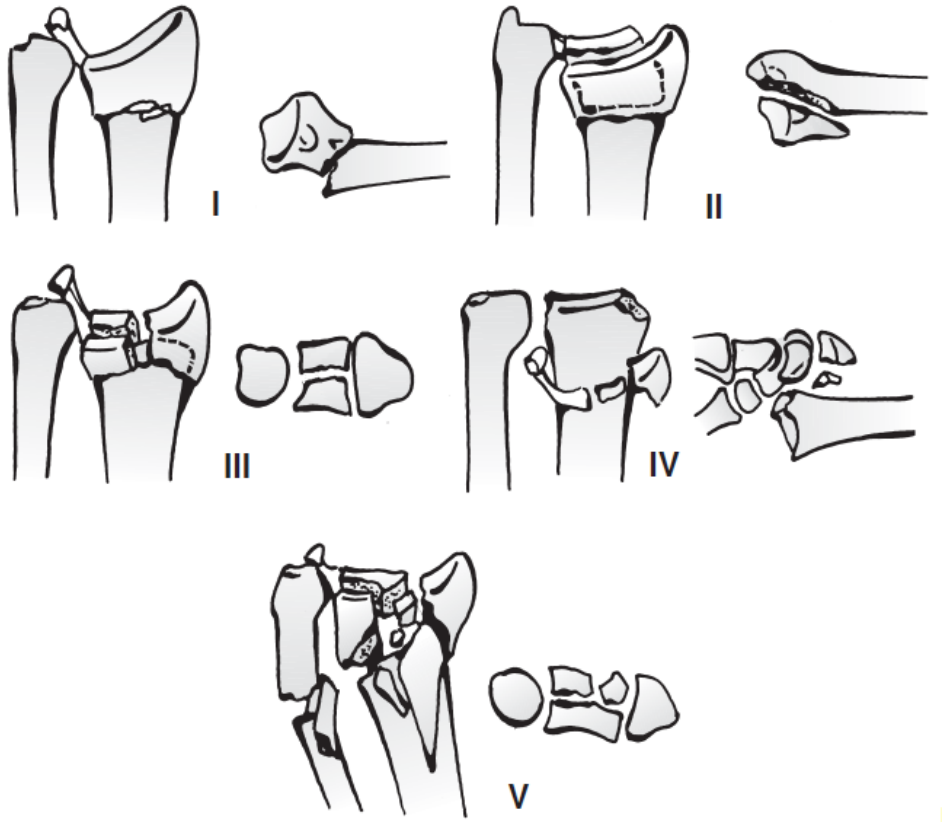
Type II- The DRUJ is subluxed or dislocated along with a fracture at the base of the ulna styloid or TFCC tear.

Type III- Potentially unstable lesions with a displaced fracture involving ulnar head or sigmoid notch.

Type IV- Unstable comminuted radiocarpal fracture

Type V-High velocity injury; combined fractures (I,II,III,IV types)

Fernandez classification

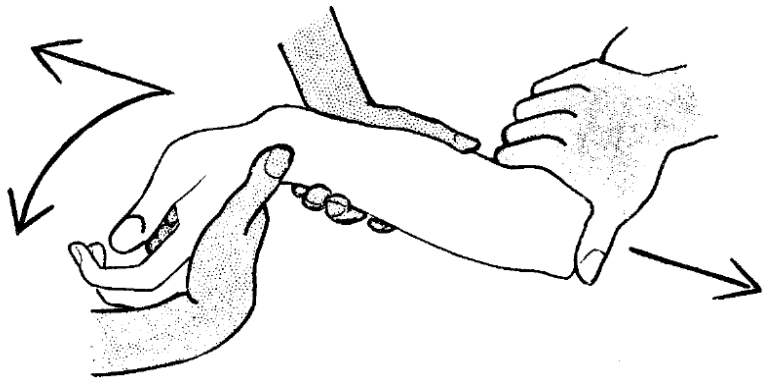


Methods of Closed Reduction

1) Charnley's method

Step 1- Disimpaction

An assistant takes hold of the elbow and offers counter-traction. The surgeon applies traction with the right hand, sited as just described, at the same time



Step 2- Reduction

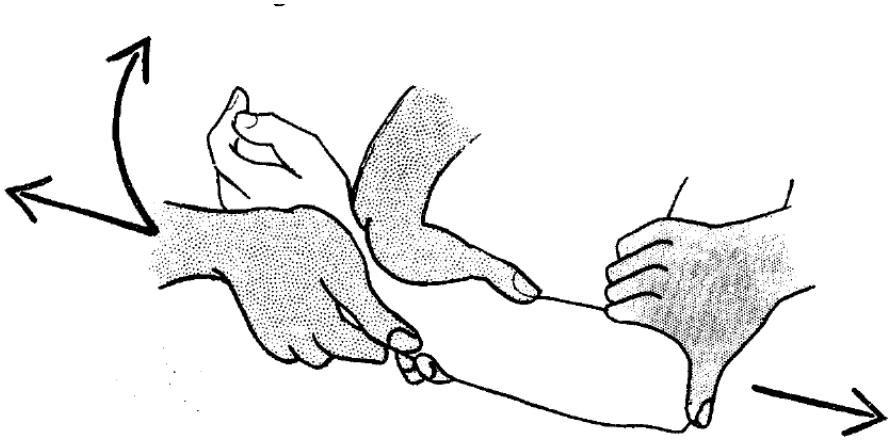


FIG. 106

Robert Jones grip applied. Pressure is applied with 'reducing' hand on distal fragment against the counter-pressure on the proximal fragment from the 'anvil' hand. Traction maintained.

Step 3- Locking the reduction by pronation

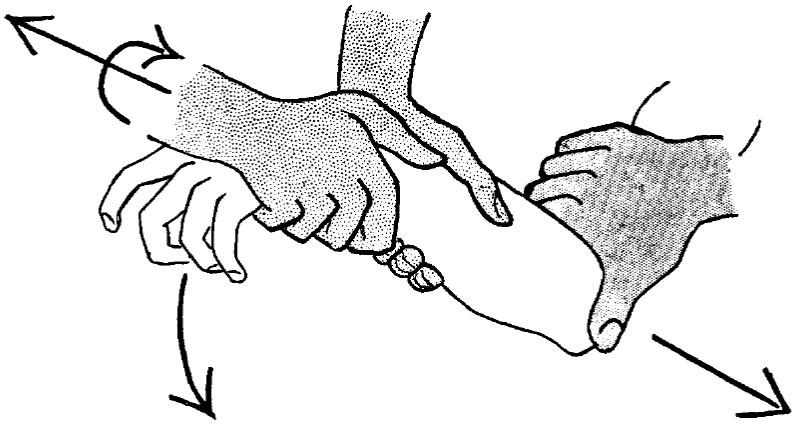


FIG. 107

Locking the reduction by pronation. The ' anvil ' hand remains stationary while the pronation is done entirely by the ' reducing ' hand. The wrist is forced into ulnar deviation by this same manœuvre.

Step 4-Plastering technique

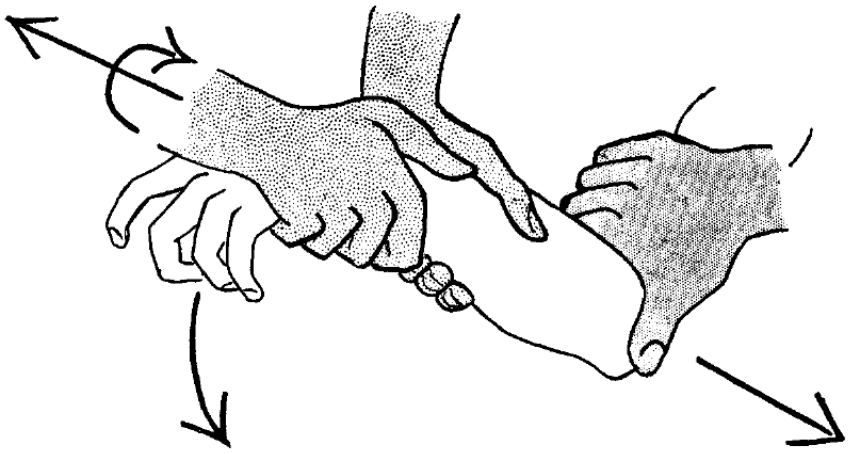


FIG. 107

Locking the reduction by pronation. The ' anvil ' hand remains stationary while the pronation is done entirely by the ' reducing ' hand. The wrist is forced into ulnar deviation by this same manœuvre.

Agee's manoeuvre [37]

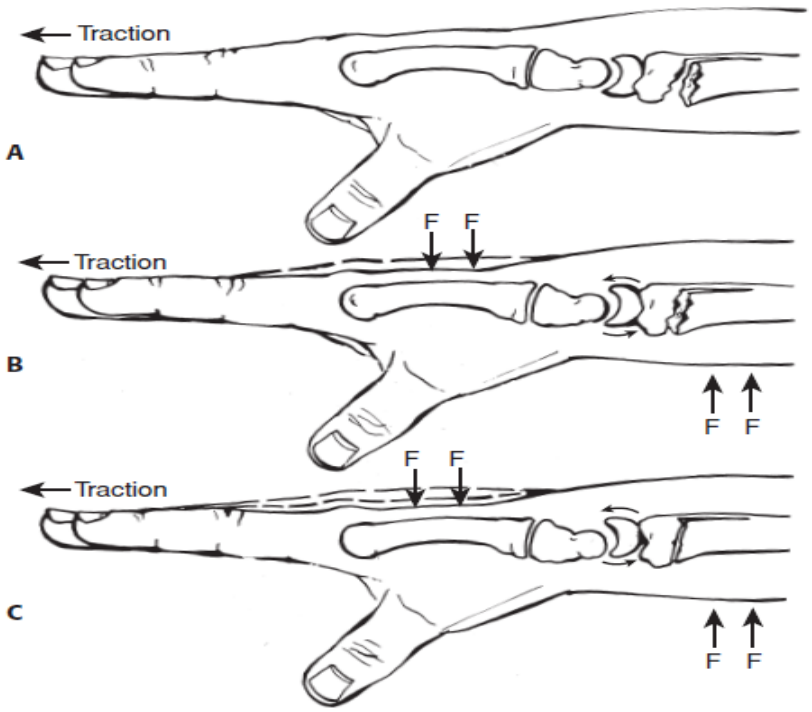


FIGURE 32-13 To apply the Agee maneuver, traction is first applied either manually or with fingertraps **(A).** A volar translation force *(F)* is applied to the distal fragment of the radius **(B).** The lunate translates on the distal radius, causing the distal fragment to tilt in a volar direction **(C).** (From Court-Brown C, McQueen M, Tornetta P. *Ortho-*

Methods of Surgical Intervention

Closed reduction and percutaneous pinning

Percutaneous pinning following closed reduction is generally useful for fractures that are unstable after closed reduction such as fractures with metaphyseal comminution and intra-articular extension [38].

After achieving anatomic reduction by closed means the fracture is stabilised with k-wires. This technique for fixation of distal radius fractures is relatively simple and inexpensive.

The major disadvantages however with conventional crossed pin configuration of percutaneous pinning is the need for cast immobilisation and the oblique orientation of pins which do not prevent the collapse that occurs at the fracture site.

Closed reduction and percutaneous pinning

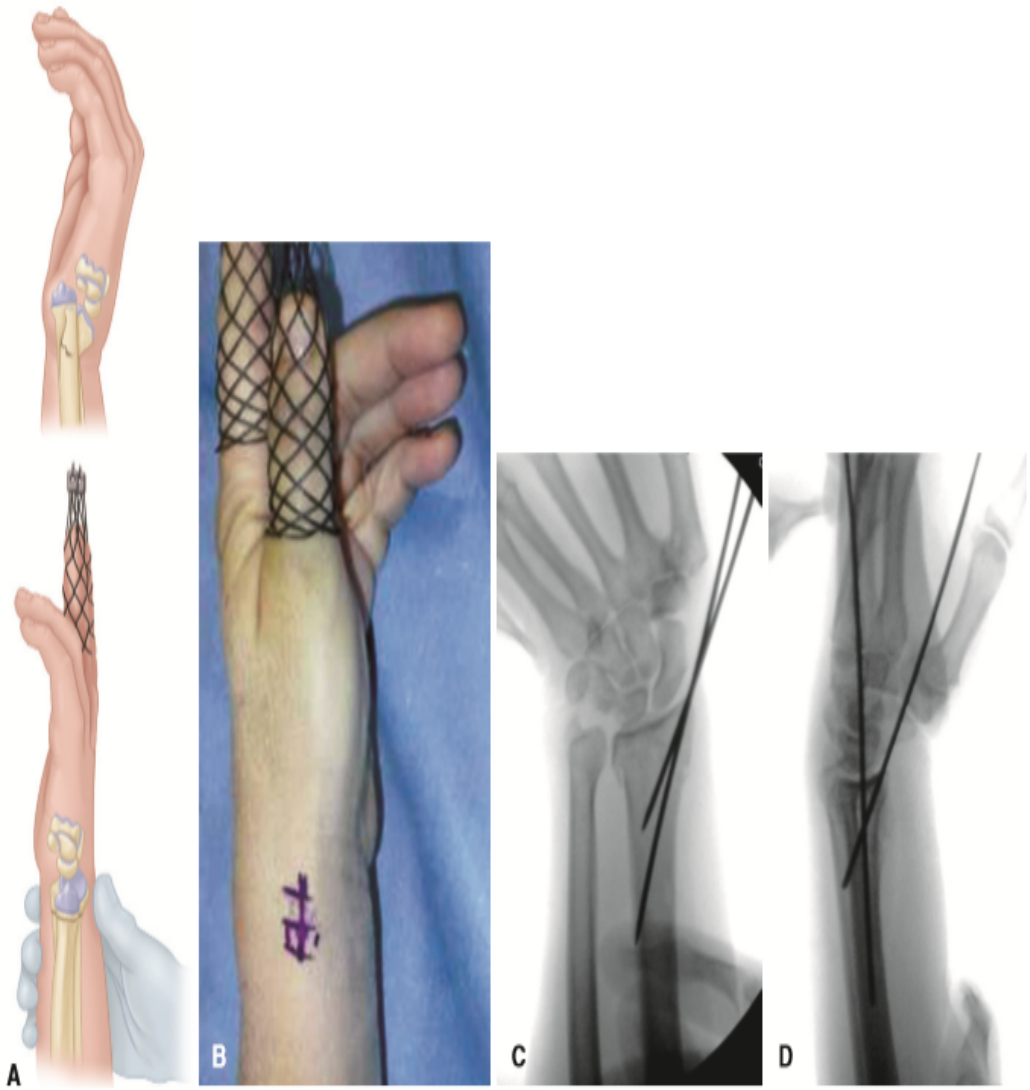


FIGURE 57-92 Closed reduction and percutaneous fixation of distal radial fractures. **A,** Fracture reduction. Suspension from finger allows disimpaction of the fracture, followed by pressure applied with thumb over distal fragment. **B,** Longitudinal incision. **C,** Percutaneous pinning confirmed fluoroscopically. **D,** Crossed pin configuration. (From Wolfe SW: Distal radius fractures. In Wolfe SW,

Common complications that occur after percutanous pinning are:

1) Superficial pin site infection [39]

2) Extensor tendon tethering

3) Pin migration and

4) Nerve injury

Kapandji intrafocal pinning

This technique of intrafocal pinning is used to prevent displacement of fracture fragments proximally and dorsally thereby acting as a buttress. The pins are inserted into the fracture site both dorsally and radially and then levered up and directed into the proximal intact cortex [40].

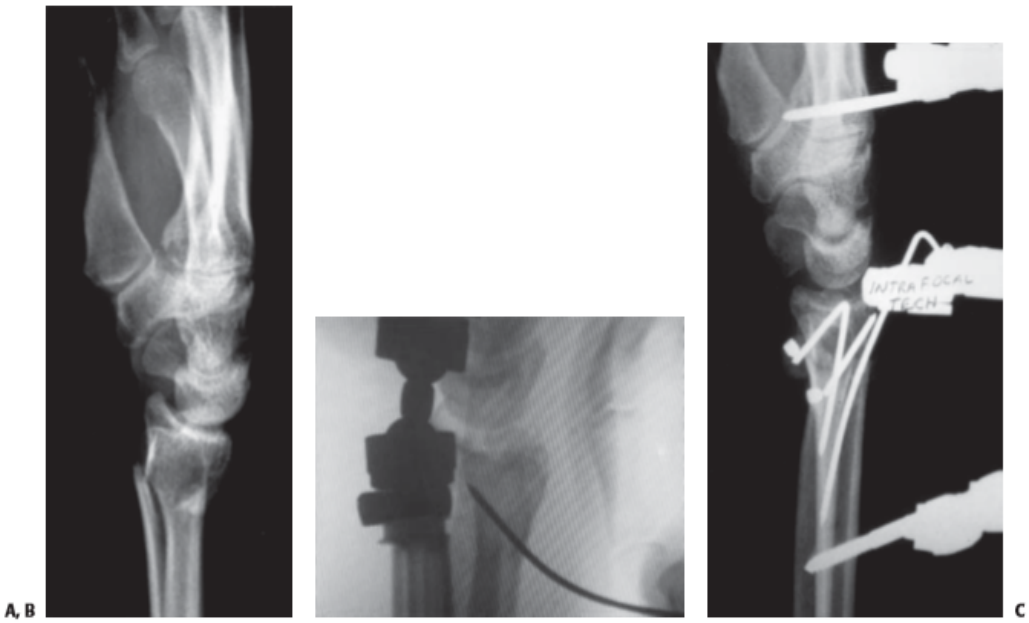


FIGURE 32-16 The Kapandji Technique: Metaphyseal fracture with redisplacement after reduction **(A)**. A pin is inserted into the fracture site, manipulated to elevate the fragment distally **(B)**, and then driven into the opposite cortex **(C)**. The fragments are thus trapped and prevented from dorsal displacement.

Other treatment modalities available

External fixator

-Spanning

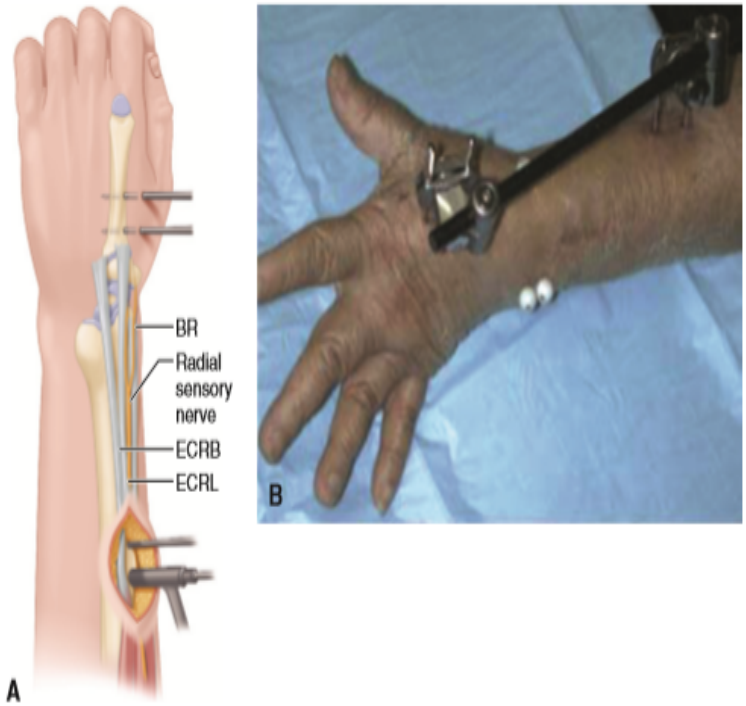


FIGURE 57-93 **A,** Two 3-mm half pins introduced into base or second metacarpal and two into distal radius. BR, brachioradialis; ECRB, extensor carpi radialis brevis; ECRL, extensor carpi radialis longus. **B,** Single-bar frame for external fixation of distal radial fracture. (From Wolfe SW: Distal radius fractures. In Wolfe SW, Hotchkiss RN, Pederson WC, Kozin SH, editors: *Green's operative hand surgery*, ed 6. Philadelphia, 2011, Elsevier.) **SEE TECHNIQUE 57-14.**

-Augmented external fixation [41]

With supplemental Kirshner wire fixation

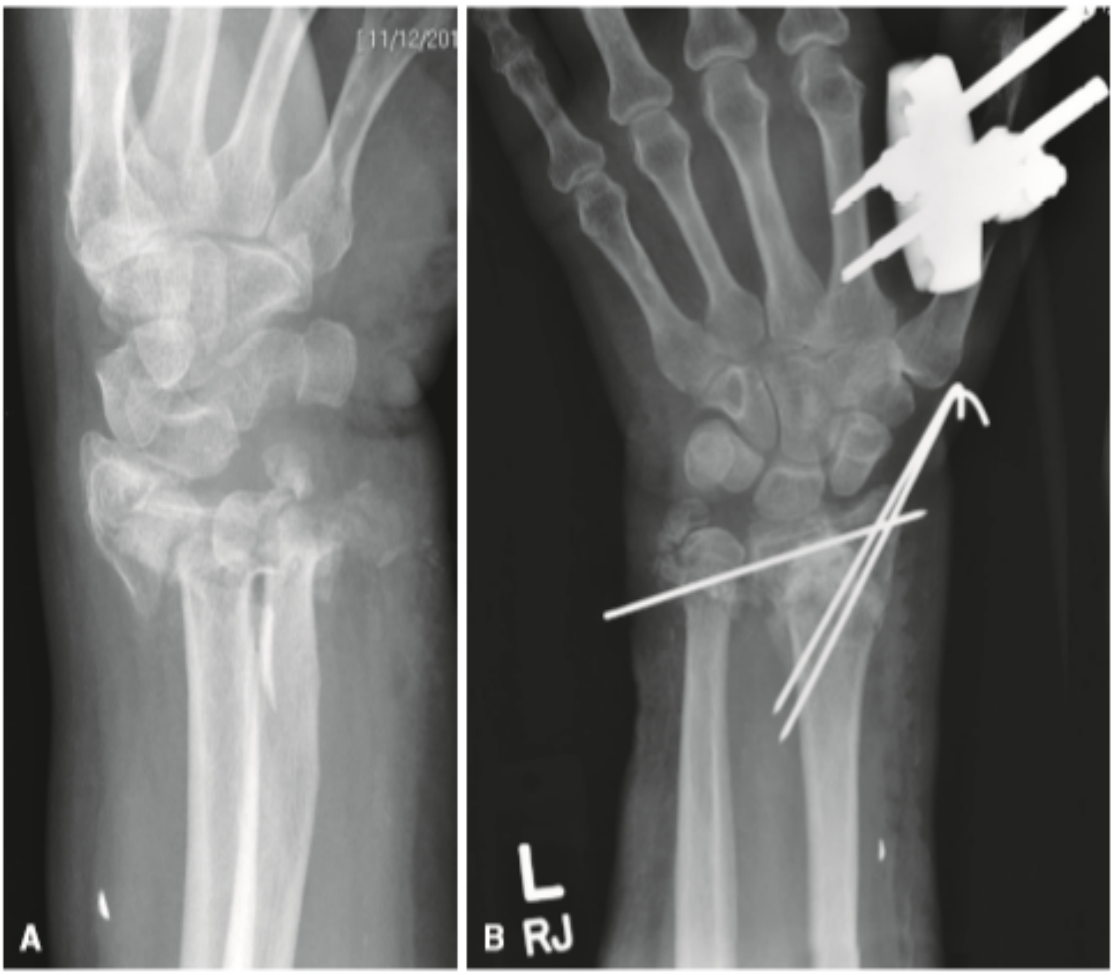


FIGURE 57-94 External fixation with supplemental percutaneous Kirschner wire fixation.

-Non spanning external fixator

Applied without spanning the wrist. This can be done in an extra-articular non comminuted fracture pattern.

Volar locking plates

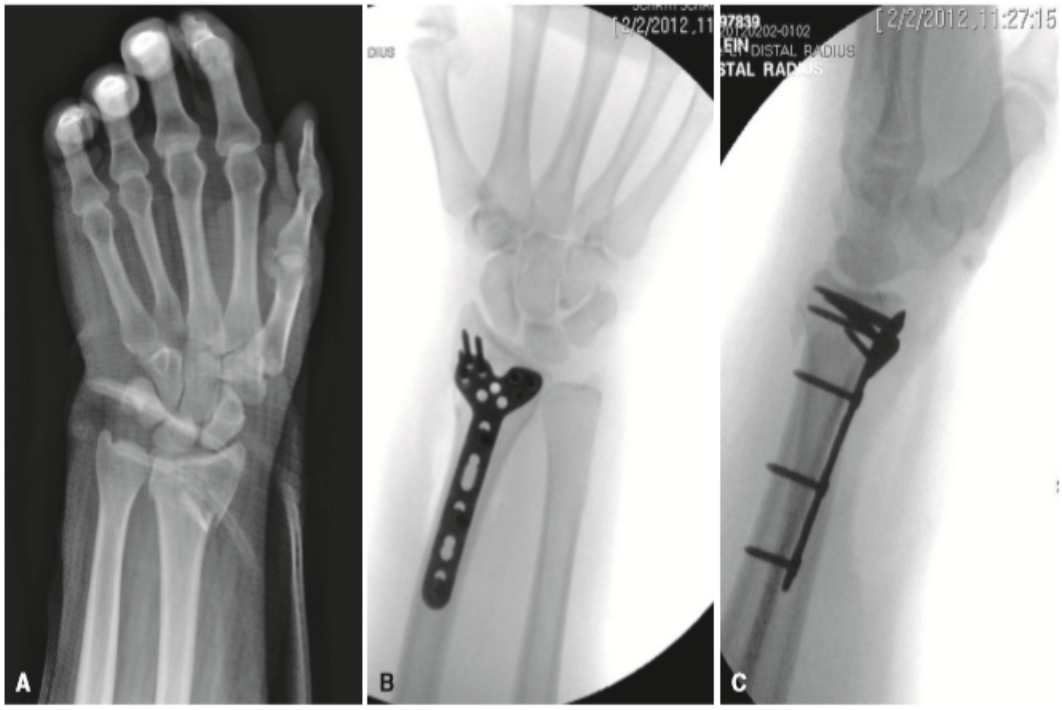


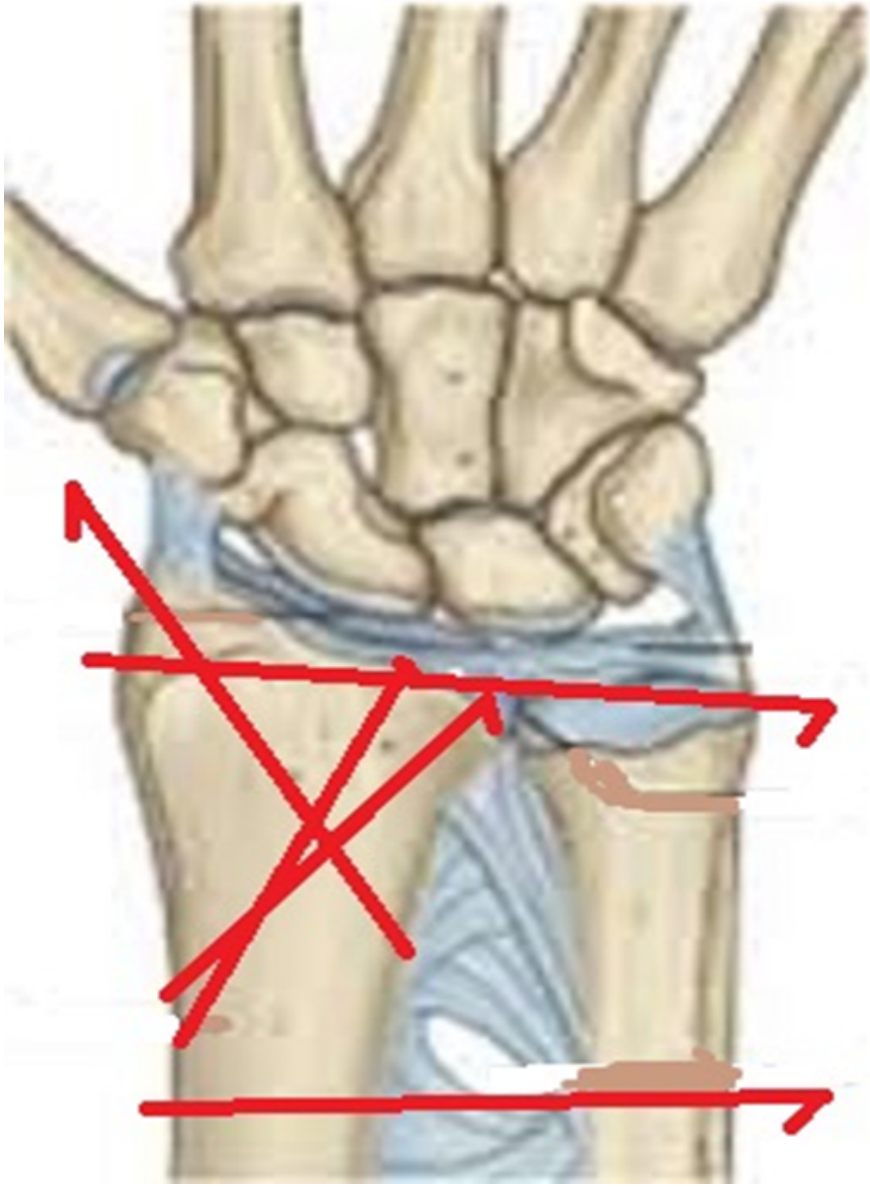
FIGURE 57-96 A-C, Volar plate fixation of distal radial fracture.

Dorsal locking plate

FIGURE 32-32 **A**: A dorsal lip fracture of the distal radius with carpal subluxation **B**: The fracture has been reduced and held with a small dorsal plate and the carpus is relocated.

The Five-Pin Technique

The five pin technique for fixation of distal radius fractures is a modification of the existing closed reduction and k-wire fixation techniques first described by Dr P.N Vasudevan in his yet to be published study. The technique involves closed reduction followed by internal fixation with five k-wires.



Advantages of the five pin technique

1) Superior to routine K-wire fixation

This technique is superior in that it provides a more stable fixation by providing rotational stability.

2) Early mobilisation

As it provides a stable fixation early mobilisation can be started in most cases thus avoiding complications such as wrist and finger stiffness.

3) Non invasiveness

As it is a closed procedure it is relatively safe thus combining the advantages of casting and plate fixation.

4) Technically less demanding

It is technically less demanding compared to a plate fixation but provides results comparable to volar plate fixation.

5) Cost saving intervention

It is a cost saving intervention compared to the volar locking plate with similar health benefits as concluded from the DRAAFT trial.

6) Fewer complications

- Superficial pin tract infections which resolves on removal of pins, regular dressing and oral antibiotic therapy.

- Late collapse
- Malunion

Principles and Mechanism

The routine K-wire fixation provides coronal and saggital plane stability but fails to provide rotational stability as the wires converge and cross at a point at or near the fracture.

Therefore, however many pins we apply across the fracture they function as a single pin as depicted in the picture below making the fracture rotationally unstable.

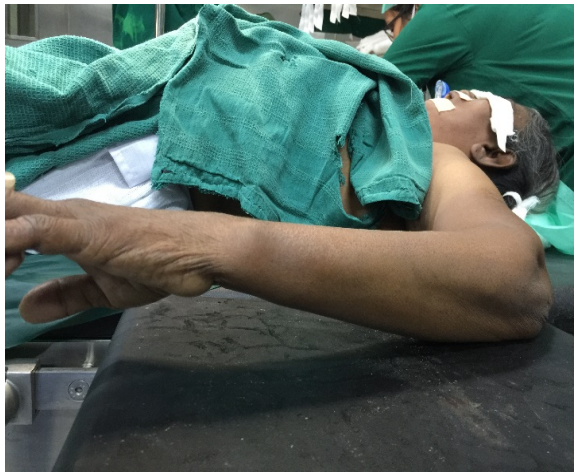
To overcome this Achilles heel of closed pinning techniques we add two radioulnar pins to transfix the distal radioulnar joint and provide rotational stability.

The added advantage in doing this is that the radial length is kept constant during union. As the distal radius is notorious for late collapse which is an important influencing factor for a poorer outcome, this technique effectively counters it leading onto a better functional outcome.

Fracture reduction and the five pin technique

1) Patient positioning

The patient is positioned supine with shoulder abducted to 90 degrees, elbow flexed to 90 degrees, forearm pronated and wrist in neutral position.

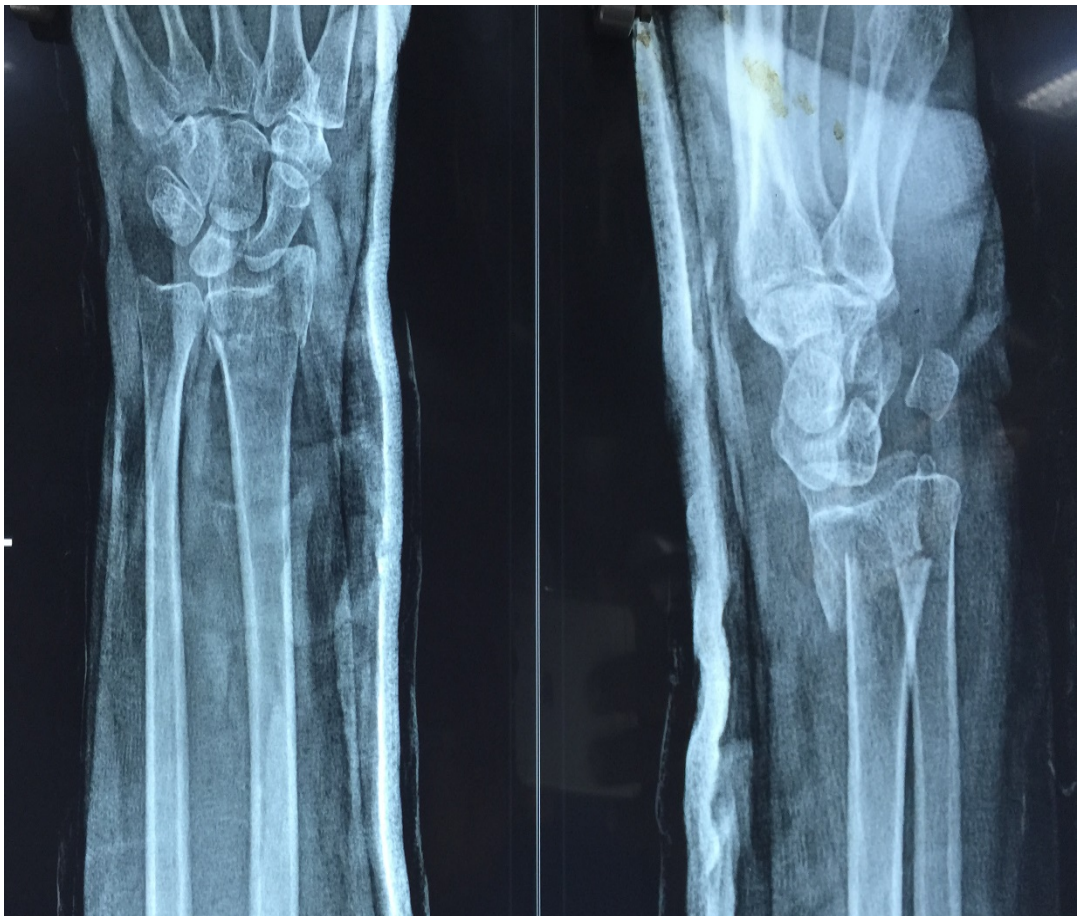


2) Closed reduction

Closed reduction is performed using Charnley's method and checked under image intensifier to confirm acceptable reduction and proceed with fixation.

3) Fixation using five pin technique

Pre-op radiograph



Fixation is done after acceptable reduction confirmed on image intensifier in the following order:

1) Radial styloid pin- From lateral to medial direction

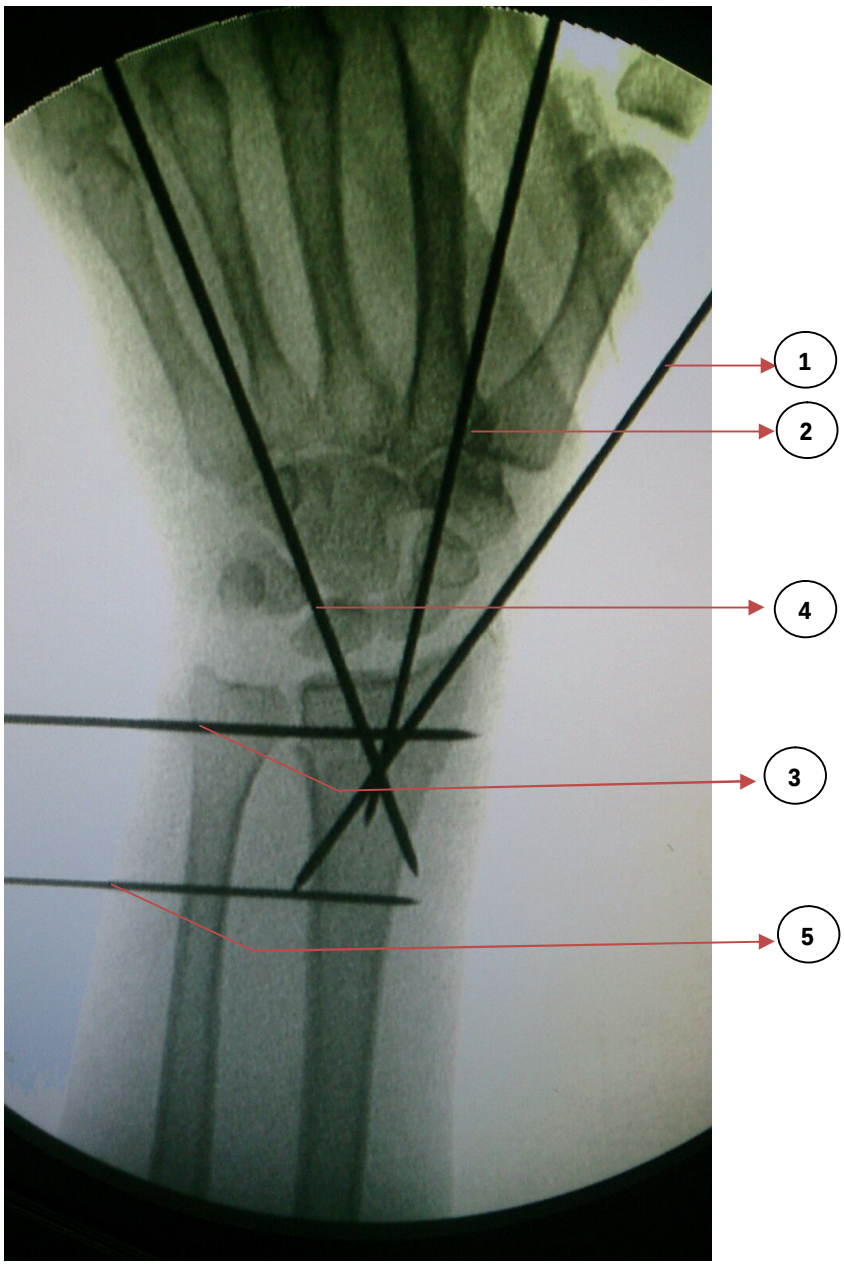
2) Lister's tubercle pin- From dorsal to volar and lateral to medial direction

3) Distal radioulnar pin – Just below articular surface in ulno-radial direction

4) Medial corner pin- From dorsal to volar and medial to lateral direction

5) Proximal radioulnar pin- 5 cm from wrist joint and in ulno-radial direction

Fixation using five pin technique



Fixation using five pin technique

Implants used

1.8 and 2 mm Kirschner wires

Smooth pins

Double cortical purchase recommended

Intrafocal pins accepted

Materials and Methods

Twenty patients with fracture of distal radius who were admitted at the emergency department and subsequently underwent five pin fixation and also those who had come to the out patient department for follow up after surgery at Institute Of Orthopaedics And Traumatology , Madras Medical College And Rajiv Gandhi Government General Hospital were studied between August 2015 and August 2016 .The patients were subjected to history taking ,thorough clinical examination with analysis of pre operative and post operative radiographs .The radiographic analysis includes evaluation of standard antero-posterior and lateral view of X rays of the wrist joint of bilateral upper limb .

Inclusion criteria

- Age greater than 20 years .
- Patients with displaced intra articular and extra articular fractures of the distal radius .

Exclusion criteria

- Age lesser than 20 years .
- Patients with Barton's fracture (Isolated dorsal or volar lip fractures of the distal radius with subluxation of the carpus)
- Patients with compound fracture.

- Patients with associated ipsilateral upper limb trauma.

Patients with the fracture of the distal radius were chosen strictly based on the above mentioned inclusion and exclusion criteria. The patients with the fracture of the distal radius were treated by fixation using 5-pin technique .

Post operatively the patients were assessed based on the functional and the radiological outcome . The follow up was based on the quick DASH scoring system to assess the functional outcome and the Sarmiento's modification of the Lindstrom criteria to assess the radiological outcome . The relationship between both outcomes were studied.

Functional outcome

The evaluation of the functional outcome of the patients with fracture of the distal radius fixed with 5-pin technique was done using the **quick DASH scoring system** . The quick DASH scoring system is a 9 item self – report questionnaire which is the shortened and modified version of the Disability of the Arm , Shoulder and Hand (DASH) scoring system . The DASH scoring system is designed to evaluate disorders and to measure disabilitites of the upper extremities and to monitor change or function over time .It facilitates to assess the functional limitations of the

patients with any musculoskeletal disorders of the upper limb by measuring the symptoms and the function/disability [42].

Radiological outcome

The evaluation of the radiological outcome of the patients with fracture of the distal radius fixed using the 5-pin technique was done using the Sarmiento's modification of the Lindstorm criteria [43]. The assessment was based on the residual radial angulation, radial shortening and the loss of radial inclination .

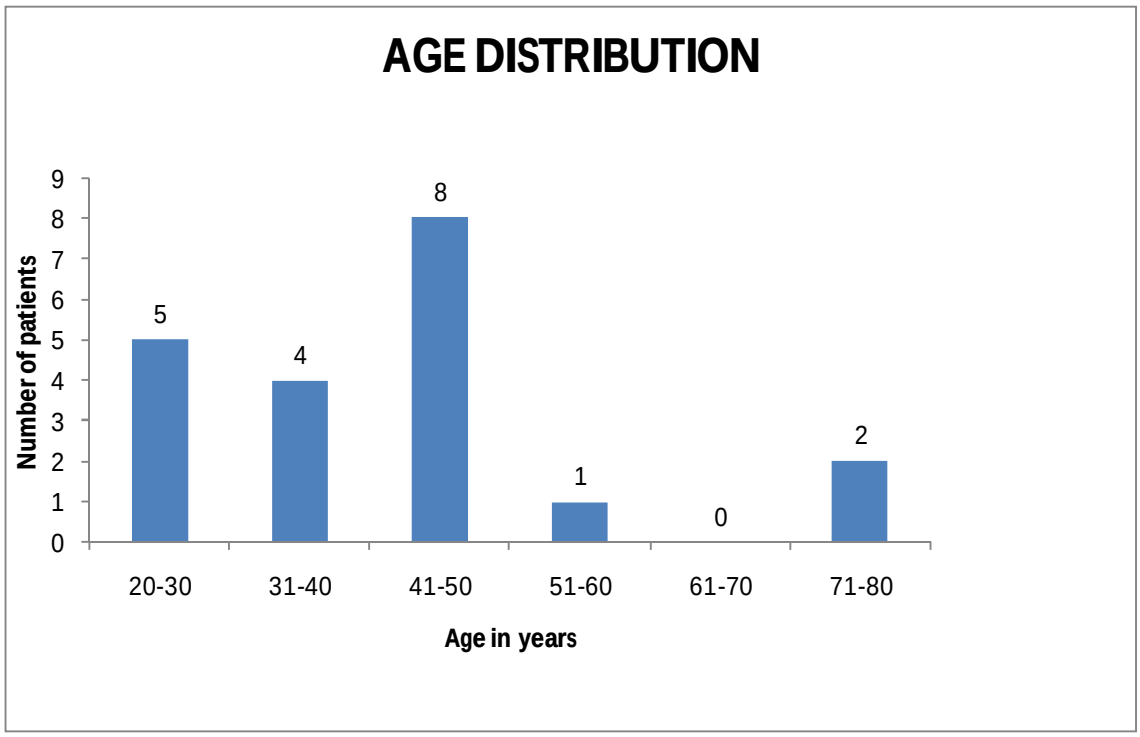
Sarmiento's modification of Lindstorm criteria

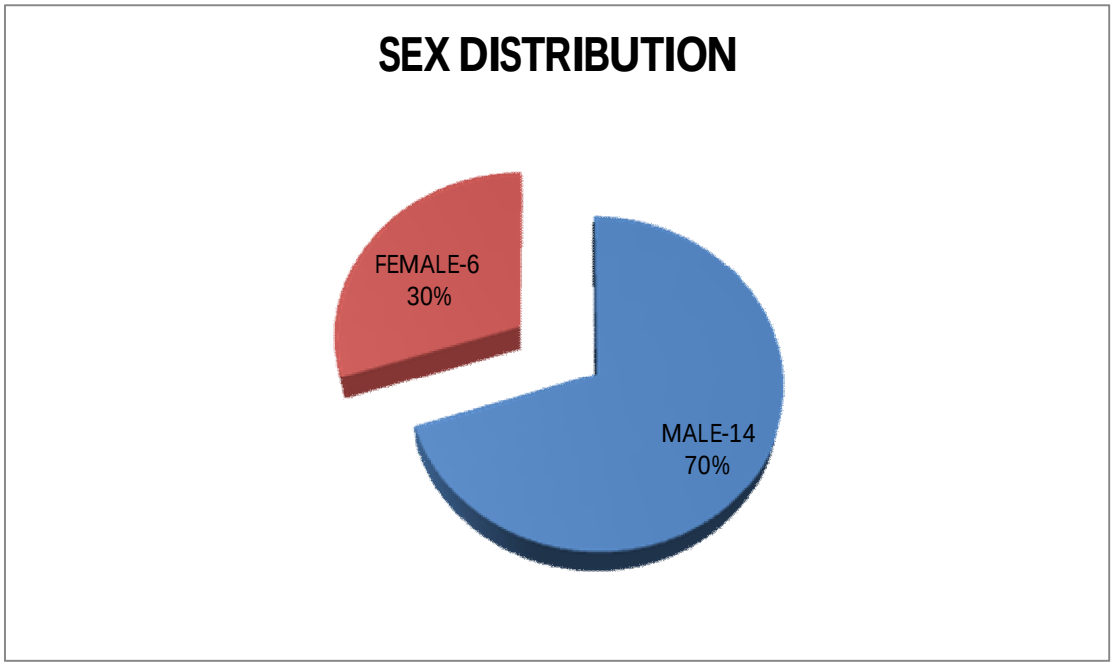
	Deformity	Residual dorsal tilt	Radial shortening	Loss of radial inclination
EXCELLENT	No or insignificant	0^0	<3 mm	$<5^0$
GOOD	Slight	1^0 to 10^0	3 to 6mm	5^0 to 9^0
FAIR	Moderate	$11^0$to 14^0	7 to 11 mm	10^0 to 14^0
POOR	severe	Atleast 15^0	Atleast 12 mm	$>14^0$

Observation and Results

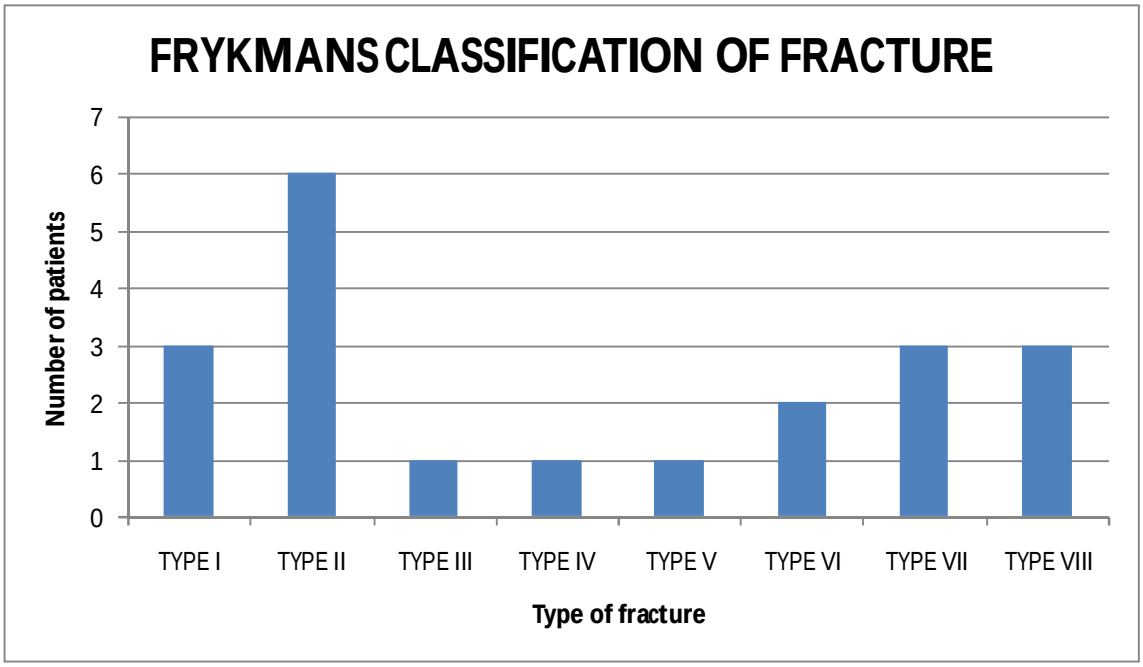
Twenty patients with fracture of the distal radius were studied both prospectively and retrospectively at the Institute of Orthopaedics And Traumatology, Madras Medical College and Rajiv Gandhi government General Hospital ,Chennai from august 2015 to august 2016 .

The mean age of the patients at the time of presentation of the fracture was 45 years with the youngest patient being 21 years and the oldest patient being 75 years .

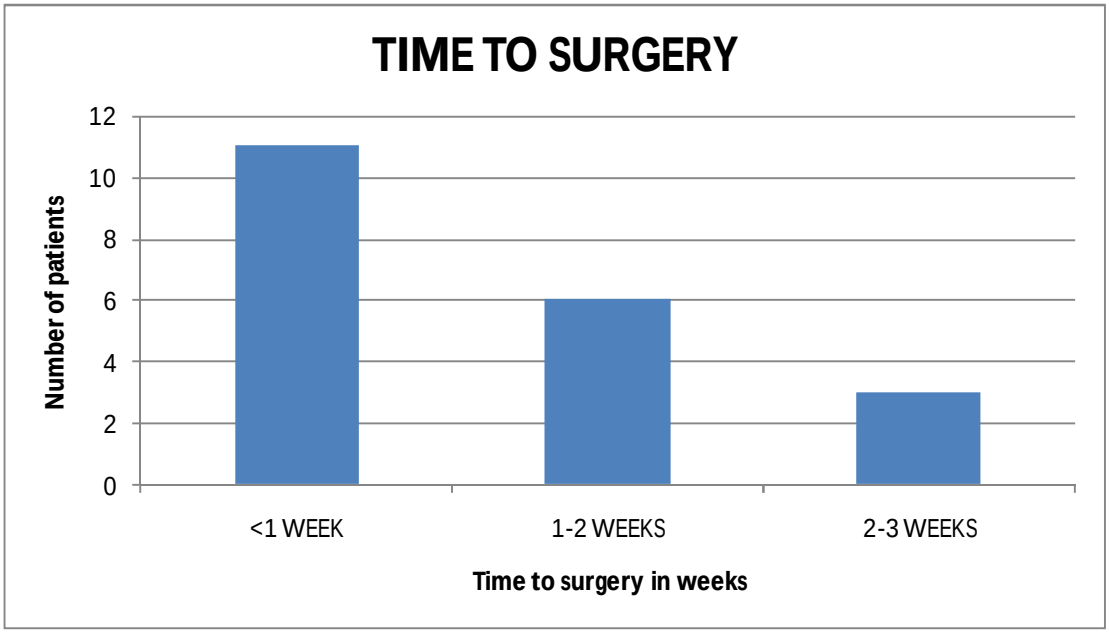




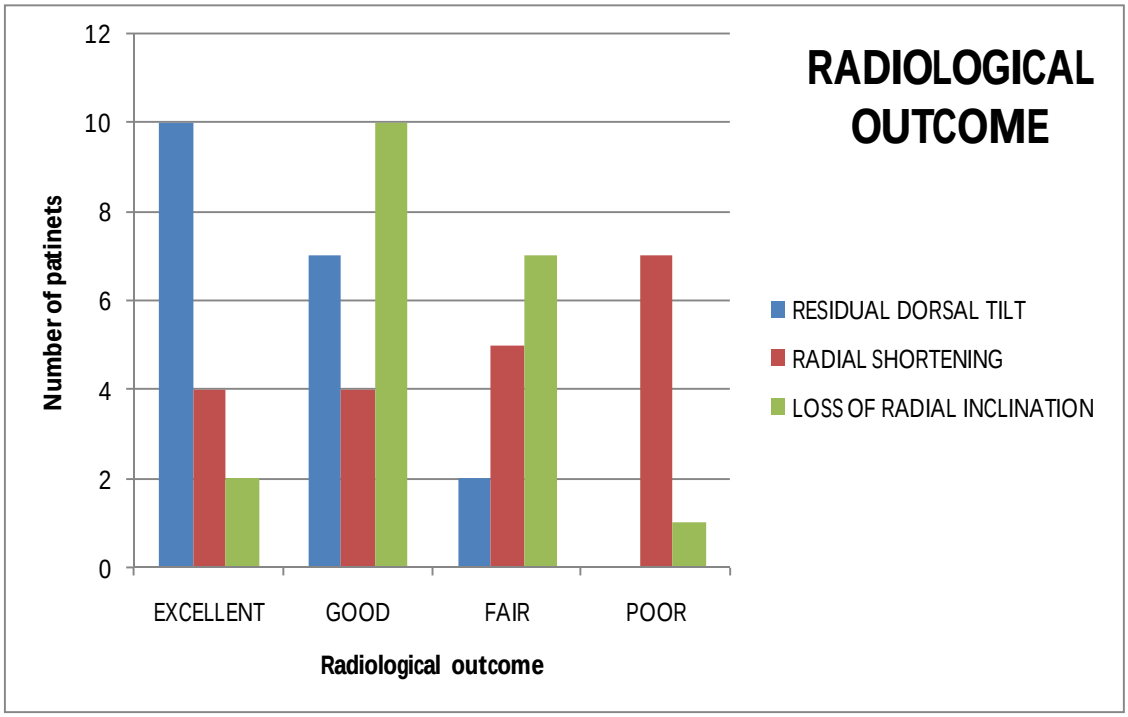
There were 14 male patients (70 %) and 6 female patients (30%).



Based on the pre operative radiographs ,Frykmans classification was applied .There were 3 patients with Type I fracture, 6 patients with Type II fracture , one patient with Type III fracture, one patient with Type IV fracture , one patient with type V fracture , two patients with Type VI fracture , three patients with Type VII fracture ,three patients with Type VIII fracture.



Most of the patients were operated within one or two days of attending the emergency department at our hospital . 11 patients were operated in <1 week , 6 patients in 1-2 weeks and 3 patients were operated by 2-3 weeks .



The patients were followed up for three months. The radiological and functional outcome were evaluated based on the follow up at 4 weeks, 6 weeks , 8 weeks and 12 weeks .

The radiological outcome was evaluated based on three parameters given by the Sarmeinto's Modification of The Lindstorm Criteria.

- Residual dorsal tilt

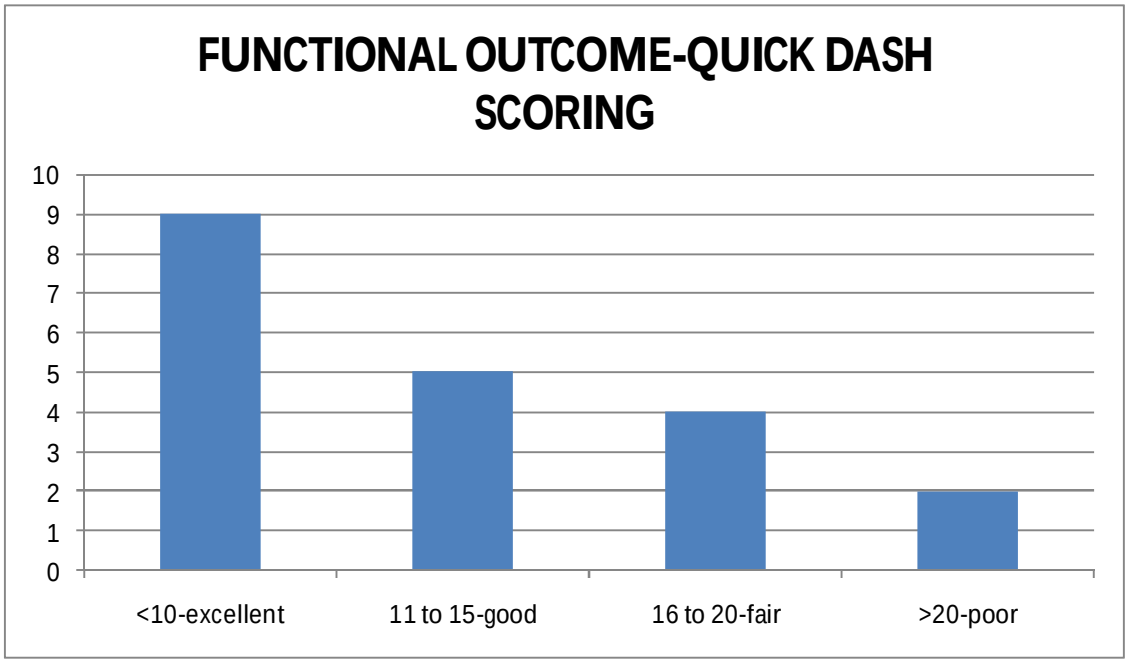
Residual dorsal tilt was found to be excellent with 10 patients ,good with 7 patients and fair with 2 patients.

- Radial shortening

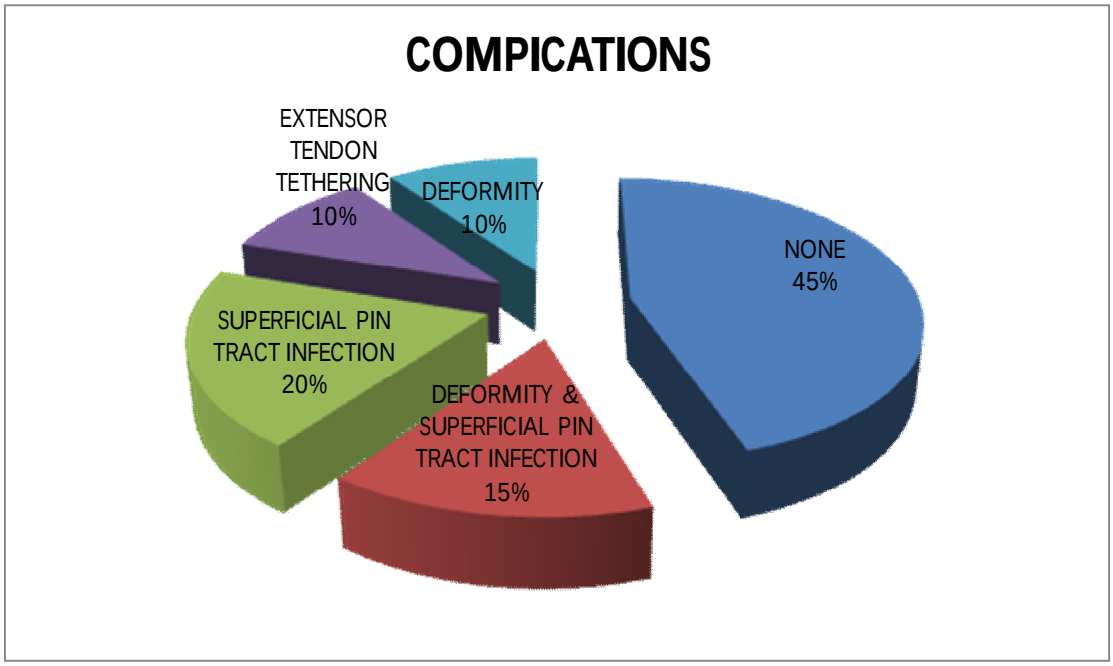
Radial shortening was found to be excellent with 4 patients, good with 4 patients ,fair with 5 patients and poor with 7 patients .

- Loss of radial inclination .

Loss of radial inclination was found to be excellent with 2 patients , good with 10 patients , fair with 7 patients and poor with one patient



The functional outcome was evaluated using the quick DASH scoring system. The scores were found to be excellent or good in most cases (lower scores) and comparable to volar plate fixation as found in other studies.



The most commonly encountered complications were superficial pin tract infection (30%) and extensor tendon tethering which were less serious complications and resolved on removal of pins. Late fracture collapse and malunion (25%) were more serious complications though not always led to a poorer outcome.

Discussion

Distal radius fractures are one of the most commonly encountered fractures in clinical practice with elderly women being the most commonly affected. These seemingly simple fractures can cause the patient significant distress and disability if treated inadequately.

The debate over the optimal treatment for distal radius fractures only sparks more questions than answers with the options ranging from conventional cast immobilisation to column specific plating. Therefore, as we are forced to draw a balance we have resorted to combining the advantages of age old casting and invasive plating, the five pin technique a modification of the existing closed reduction and pinning methods.

Closed reduction and cast immobilisation although simple and convenient leads on to a high rate of disabling stiffness and late fracture collapse eventually leading onto a poor functional outcome. Open reduction and plating although provides an opportunity to reduce the fracture anatomically comes with own set of complications related to the invasiveness of the procedure.

The goals of managing distal radius fractures are anatomic reduction, fracture stability, early mobilisation, pain-free range of movements and minimal complications. All the afore mentioned goals

can be achieved using the five pin technique for fixation of distal radius fractures.

The five pin technique carries the advantages of early mobilisation in stable fractures without severe articular comminution. This is because the radioulnar pins and the pins across the fracture site provide stability enough to permit early mobilisation leading onto lesser stiffness post-operatively.

Another significant advantage the five pin technique provides is in its versatility. Distal radius fractures occur in innumerable patterns hence it is important to individualise treatment. This technique helps us achieve a much desired fragment specific fixation.

The most important radiological factors that dictate outcome are:

1. Radial height
2. Ulnar variance
3. Palmar tilt
4. Carpal alignment
5. Articular alignment

Although radiological outcome does not correlate always with good functional outcome it is among the only modifiable factors in determining the outcome.

Solgaard after studying 269 patients retrospectively concluded that radial height was the most important radiological parameter that correlated with a good functional outcome [44].

Wilcke et al from his study pointed out the association between a loss of radial inclination more than 10 degrees and a poor DASH score [45].

Van der Linden and Ericson after studying 250 patients concluded that better reduction of dorsal tilt led to better outcome in the form of grip strength, range of movement and residual pain [46].

In our study of 20 patients including both intra and extra-articular fractures reduction of dorsal tilt correlated with the DASH score 80% of the time, the radial length 65% of the time and the radial inclination 60% of the time.

Schneiders et al in 2006 concluded that the main radiological factors influencing outcome are the radial length and intra-articular step off after studying 344 patients [47].

However, in our study reduction of the dorsal tilt has correlated with a better functional outcome more than radial length or inclination. But the small sample size therefore makes any statistical analysis insignificant and further studies are needed to evaluate our observation.

Porter et al after studying 115 patients concluded that only when the dorsal tilt exceeded 20 degrees and the radial angle reduced to less than 10 degrees reduction in grip strength was seen [48].

A similar observation was made in our study as well and what we would like to conclude from this observation is that only a reasonable and not an absolute anatomic reduction is essential for a good functional outcome.

The DASH scores in the study by Brennan et al comparing K-wire fixation vs volar plating was 13.12 vs 11.25 [24] .

The DASH scores in our study were excellent or good in most cases. The average DASH being 12.68 which is comparable to volar plating and better than conventional K-wire fixation as seen from other studies [23].

On analysis of patients with fair or poor DASH scores one case presented late making anatomic restoration not possible, one case had poor anatomic reduction leading onto residual dorsal tilt, other cases had

either severe metaphyseal or articular comminution leading onto late fracture collapse and malunion.

Complications were encountered in the form of superficial pin site infections (30%), deformity and fracture collapse (22%) and extensor tendon tethering in (10%). The superficial pin site infections settled with removal of infected pins and oral antibiotics and cases with extensor tendon tethering also resolved with removal of offending pins. The deformity and fracture collapse though not always led to a poorer functional outcome.

Although the study series is small and further research is essential to provide directions for treatment, it is safe to conclude that the five pin technique is a technically less demanding, non-invasive and an effective way of treating both displaced intra and extra-articular distal radius fractures without severe articular or metaphyseal comminution. The cases with delayed presentations and severe comminution certainly need open reduction and a more stable fixation in the form of plating.

Conclusion

‘The five pin technique’ is a minimally invasive and effective means of treating displaced intra and extra-articular fractures without severe articular and metaphyseal comminution.

From our study it was observed that correction of dorsal tilt closely correlated with a better functional outcome contrary to literature although further studies are necessary to evaluate this observation.

Complications were observed in the form of superficial pin tract infection and extensor tendon tethering which resolved on removal of the pins. Late fracture collapse and malunion in cases with severe metaphyseal or articular comminution were more serious complications which led to a poorer outcome.

Although a versatile technique the five pin fixation doesn’t come without its limitations. Delayed presentations and cases with high degrees of instability necessitate open reduction and a more stable fixation.

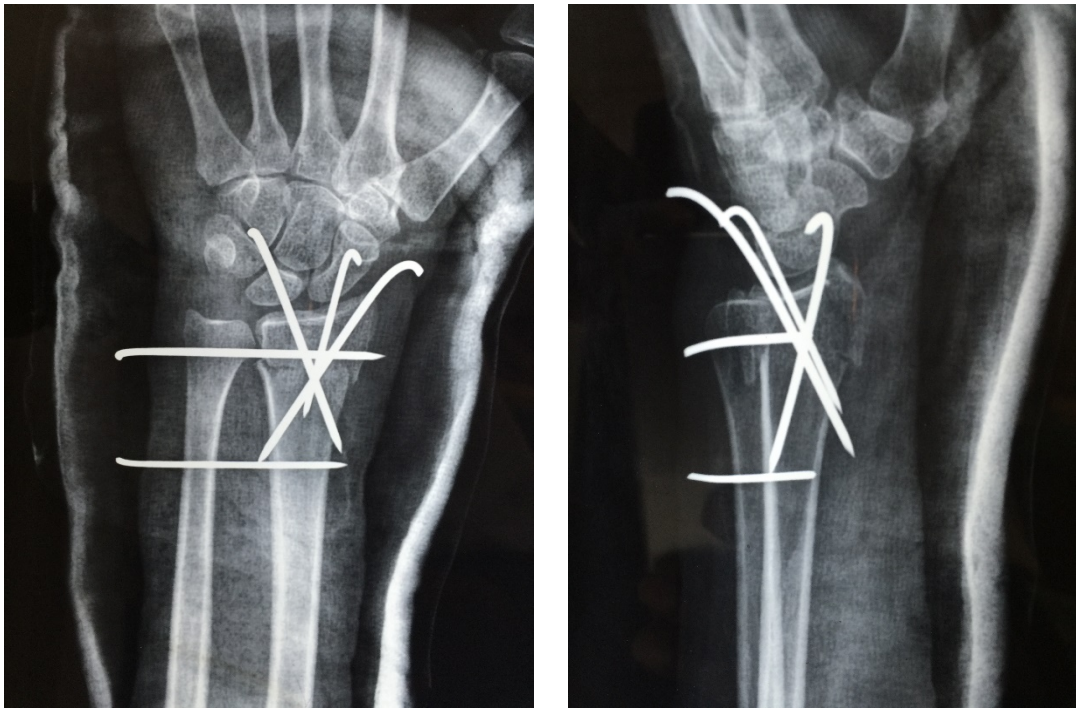
In conclusion, the five pin technique is a versatile tool which provides functional outcomes better than conventional k-wire fixation and comparable to volar plating as seen in our study. However further studies with a larger series are needed to provide future directions.

Case Illustrations

Case 1

Pre-op Radiographs

Post-op Radiographs



Follow up Radiographs

Clinical Photographs

Case 2

Pre-op Radiographs

Post-op Radiographs

Follow up Radiographs

Clinical Photographs

Case 3

Pre-op Radiographs

Post-op Radiographs

Follow up Radiographs

Clinical Photographs

Case 4

Pre-op Radiographs

Post-op Radiographs

Follow up Radiographs

Clinical Photographs

Case 5

Pre-op Radiographs

Post-op Radiographs

Follow up Radiographs

Clinical Photographs

Bibliography

1. Court-Brown CM, Caesar B. Epidemiology of adult fractures: A review. Injury. 2006;37:691–697.
2. Colles A. On the fracture of the carpal extremity of the radius. Edinburgh Med Surg1814;10:182–6.
3. Lilienfeldt A. Ueber den klassischenRadiusbruch. Arch KlinChir. 1885;27:475
4. Lindau T, Arner M, Hagberg L. Intraarticular lesions in distal fractures of the radius in young adults. A descriptive arthroscopic study in 50 patients. J Hand Surg Br. 1997;22: 638–643.
5. Zemel NP: The prevention and treatment of complications from fractures of the distal radius and ulna. Hand Clin. 1987;3:1 – 11
6. Pouteau C. Oeuvres Posthumes de M. Pouteau. http://books google sh/books/about/Oeuvres_posthumes_de_m_Pouteauhtml?id=0hm3 HTopvSgC. 1783.
7. Colles A. On the fracture of the carpal extremity of the radius. Edinb Med Surg J. 1814; 10:181. ClinOrthopRelat Res. 2006;445:5–7.
8. Smith R. A Treatise on Fractures in the Vicinity of Joints and on Certain Forms of Accidental and Congenital Dislocations. Dublin: Hodges and Smith, 1854.
9. Jones R (ed): Injuries of joints. London, England, Henry Frowde& Hodder &Stoughon, 1915, p 110
10. Bohler L (ed): The Treatment of Fractures. Vienna, Austria, W Maudrich,1929.
11. Charnley J. The mechanics of conservative treatment. In: The closed treatment of common fractures. London: Greenwich Medical Media; 2003. p. 43–59. 22

12. Frykman G. Fracture of the distal radius including sequelae–shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function. A clinical and experimental study. ActaOrthop Scand. 1967;108(suppl).
13. Sarmiento A, Pratt GAW, Berry NC, Sinclair WF: Colles fractures: Functional Bracing in supination. J Bone Joint Surg 1975;57A:311-317.
14. Melone CP Jr. Articular fractures of the distal radius. OrthopClin North Am. 1984;15: 217–236.
15. Bartosh RA, Saldana MJ. Intrarticular fractures of the distal radius: a cadaveric study to determine if ligamentotaxis restores radiopalmar tilt. J Hand Surg [Am] 1990;15(1):18-21
16. Connoly J. Fractures and Dislocations. Closed Management. Philadelphia: WB Saunders, 1995
17. Castaing J: Recent fractures of the inferior extremity of the radius in the adult (French). Rev ChirOrthop 50:582-696, 1964
18. Kapandji A: Bone fixation by double percutaneous pinning. Functional treatment of non-articular fractures of the distal radius [French]. Ann Chir Main 30:903-908,1976
19. Rayhack J, Langworthy J, Belsole R: Transulnar percutaneous pinning of displaced distal radial articular fractures. Presented at the American Society for surgery of the Hand Annual meeting. Orlando, FL, October 3,1991
20. Rikli DA, Regazzoni P. Fractures of the distal end of the radius treated by internal fixation and early function. A preliminary report of 20 cases. J Bone Joint Surg Br 1996;78(4):588–92.
21. Weber ER: A rationale approach for the recognition and the treatment of Colles' fracture. Hand Clin1987;3:3 – 21

22. Ashok K Shyam, Chetan Pradhan, Rajiv Arora, Gaurav Pardesi, Parag Sancheti, AtulPatil, Chetan Puram.A Comparative Study Of The Functional Outcome Of k-wire Fixation With Cast CersusLigamentotaxis In Management Of Distal End Comminuted Fracture Radius. Journal of OrthopaedicsISSN 0972-978X
23. Shuang-Le Zong,Meta-analysis for dorsally displaced distal radius fracture fixation: Volar locking plate versus percutaneous Kirschner wiresJournal of Orthopaedic Surgery and Research 10(1):108 · July 2015
24. Brennan et al ,Volar plate versus k-wire fixation of distal radius fractures JINJ 6367
25. Costa ML, Achten J, Parsons NR, Rangan A, Griffin D, Tubeuf S, Lamb SE. Percutaneous fixation with Kirschner wires versus volar locking plate fixation in adults with dorsally displaced fracture of distal radius: randomised controlled trial. BMJ 2014;349:g4807.
26. Geissler WB, Freeland AE, Savoie FH, et al. Intracarpal soft-tissue lesions associated with an intra-articular fracture of the distal end of the radius. J Bone Joint Surg Am. 1996;78:357–365.
27. Richards RS, Bennett JD, Roth JH, et al. Arthroscopic diagnosis of intra-articular soft tissue injuries associated with distal radial fractures. J Hand Surg Am. 1997;22:772–776.
28. Shih JT, Lee HM, Hou YT, et al. Arthroscopically-assisted reduction of intra-articular fractures and soft tissue management of distal radius. Hand Surg. 2001;6:127-35.
29. Medoff RJ. Essential radiographic evaluation for distal radius fractures. Hand Clin. 2005;21:279–288.
30. Smith DW, Henry MH. The 45 degrees pronated oblique view for volar fixed-angle plating of distal radius fractures. J Hand Surg Am. 2004;29:703–706.

31. Lundy D, Quisling S, Lourie G, et al. Tilted lateral radiographs in the evaluation of intra-articular distal radius fractures. J Hand Surg Am. 1999;24A:249–256.
32. Johnston GH, Friedman L, Kriegler JC. Computerized tomographic evaluation of acute distal radial fractures. J Hand Surg [Am]. 1992;17:738–744.
33. Gartland JJ Jr, Werley CW. Evaluation of healed Colles' fractures. J Bone Joint Surg Am. 1951;33-A:895–907.
34. Frykman G. Fracture of the distal radius including sequelae–shoulder-hand-finger syndrome, disturbance in the distal radio-ulnar joint and impairment of nerve function. A clinical and experimental study. ActaOrthop Scand. 1967;108(suppl).
35. Melone CP Jr. Articular fractures of the distal radius. OrthopClin North Am. 1984;15: 217–236.
36. Fernandez DL, Jupiter JB. Epidemiology, Mechanism, Classification. Fractures of the distal radius. 1st ed. New York, NY: Springer-Verlag; 1996:23–52.
37. Agee JM, Szabo RM, Chidgey LK, et al. Treatment of comminuted distal radius fractures: an approach based on pathomechanics. Orthopedics 1994;17(12):1115â€“1122.
38. Allain J, le Guilloux P, Le Mouel S, et al. Trans-styloid fixation of fractures of the distal radius. A prospective randomized comparison between 6- and 1-week postoperative immobilization in 60 fractures. ActaOrthopScand 1999;70(2):119â€“123.
39. Hargreaves DG, Drew SJ, Eckersley R. Kirschner wire pin tract infection rates: a randomized controlled trial between percutaneous and buried wires. J Hand Surg Br 2004;29:374â€“376.

40. Rosenthal AH, Chung KC. Intrafocal pinning of distal radius fractures: a simplified approach. Ann PlastSurg 2002;48(6):593â€“599.
41. Dunning CE, Lindsay CS, Bicknell RT, et al. Supplemental pinning improves the stability of external fixation in distal radius fractures during simulated finger and forearm motion. J Hand Surg1999;24:992â€“1000.
42. The shortened disabilities of the arm, shoulder and hand questionnaire (QuickDASH): validity and reliability based on responses within the full-length DASHChristina Gummesson,corresponding author1,2 Michael M Ward,1 and Isam Atroshi3BMC MusculoskeletDisord. 2006; 7: 44
43. Sarmiento A, Pratt GAW, Berry NC, Sinclair WF: Colles fractures: Functional Bracing in supination. J Bone Joint Surg 1975;57A:311-317.
44. Solgaard S. Classification of distal radius fractures. ActaOrthopScand1984;56:249â€“252.
45. J Hand Ther. 2007 Oct-Dec;20(4):290-8; quiz 299.Patient-perceived outcome after displaced distal radius fractures. A comparison between radiological parameters, objective physical variables, and the DASH score.Wilcke MK1, Abbaszadegan H, Adolphson PY
46. J Bone Joint Surg Am. 1981 Oct;63(8):1285-8.Colles' fracture. How should its displacement be measured and how should it be immobilized? Van der Linden W, Ericson R.
47. Unfallchirurg. 2006 Oct;109(10):837-44.[Distal radius fracture. Correlation between radiological and functional results].[Article in German]Schneiders W1, Biewener A, Rammelt S, Rein S, Zwipp H, Amlang M.

48. ClinOrthopRelat Res. 1987 Jul;(220):241-52.Fractures of the distal radius. Intermediate and end results in relation to radiologic parameters.Porter M, Stockley I.

Annexure

*Quick*DASH-9

INSTRUCTIONS: This questionnaire asks about your symptoms as well as your ability to perform certain activities. Please answer *every question*, based on your condition in the last week, by circling the appropriate number. If you did not have the opportunity to perform an activity in the past week, please make your *best estimate* of which response would be the most accurate. It doesn't matter which hand or arm you use to perform the activity; please answer based on your ability regardless of how you perform the task.

Rate your ability to do the following activities in the last week by circling the number below the appropriate response.

	NO DIFFICULTY	MILD DIFFICULTY	MODERATE DIFFICULTY	SEVERE DIFFICULTY	UNABLE
1. Open a tight or new jar.	0	1	2	3	4
2. Do heavy household chores (e.g., wash walls, floors).	0	1	2	3	4
3. Carry a shopping bag or briefcase.	0	1	2	3	4
4. Wash your back.	0	1	2	3	4
5. Use a knife to cut food.	0	1	2	3	4
6. Recreational activities in which you take some force or impact through your arm, shoulder or hand (e.g., golf, hammering, tennis, etc.).	0	1	2	3	4

	NOT AT ALL	SLIGHTLY	MODERATELY	QUITE A BIT	EXTREMELY
7. During the past week, *to what extent* has your arm, shoulder or hand problem interfered with your normal social activities with family, friends, neighbours or groups?	0	1	2	3	4

	NOT AT ALL	SLIGHTLY LIMITED	MODERATELY LIMITED	VERY LIMITED	UNABLE
8. During the past week, were you limited in your work or other regular daily activities as a result of your arm, shoulder or hand problem?	0	1	2	3	

	NONE	MILD	MODERATE	SEVERE	EXTREME
9. Arm, shoulder or hand pain.	0	1	2	3	4

A *Quick*DASH-9 score may not be calculated if there is greater than 1 missing item.

***Quick*DASH-9 SCORE = [(sum) x 1.1] x 5/2, a missing response is added as the average of the remaining.**

Master Chart

Name	Age /sex	Frykman classification	Time to surgery	Residual dorsal tilt	Radial shortening	Loss of radial inclination	Dash	Complication
1.Mrs.Pattama 67500	72/f	Type2	2 days	Excellent	Good	Good	8.5	Superficial pin tract infection
2.Mr.Paneer 81518	47/m	Type5	1 day	Excellent	Poor	Fair	16.5	Deformity
3.Mr.Ramasamy 70049	40/m	Type6	Same day	Excellent	Fair	Good	8.5	Nil
4.Mr.Murugan 70464	40/m	Type 7	3 days	Excellent	Excellent	Excellent	5.5	Nil
5.Mr.Mahesh 87662	25/m	Type 6	11 days	Excellent	Good	Good	5.5	Extensor tendon tethering
6.Mr.Sagaya Vincent Raj 63128	42/m	Type 7	22 days	Fair	Poor	Good	16.5	Deformity
7.Mrs.Jothi 129044	36/f	Type 8	2 weeks	Good	Fair	Fair	24.75	Deformity and superficial pin tract infection
8.Mrs.Vadivambal 135583	42/f	Type2	2 days	Excellent	Excellent	Good	5.5	Superficial pin tract infection
9.Mr.Rahul 128588	21/m	Type 8	1 week	Good	Poor	Fair	13.75	Extensor tendon tethering
10.Mr.Saravanan 163961	38/m	Type 1	1 week	Excellent	Good	Good	5.5	Superficial pin tract infection
11.Mr.Balraman 64646	75/m	Type1	4 days	Poor	Poor	Good	35.75	Deformity and superficial pin tract infection

Name	Age /sex	Frykman classification	Time to surgery	Residual dorsal tilt	Radial shortening	Loss of radial inclination	Dash	Complication
12.Mr. Karpagam 88543	43/f	Type 2	5 days	Good	Fair	Excellent	13.75	Nil
13.Mr.Prem 88914	25/m	Type2	3 days	Excellent	Fair	Fair	13.75	Nil
14.Mr.Ashwin 77681	23/m	Type 2	1 day	Good	Excellent	good	5.5	Nil
15.Mrs.Balampal 55638	50/f	Type 2	23 days	Good	Poor	Fair	13.75	Superficial pin tract infection
16.Mr.Raju Choudary 82357	28/m	Type 7	1 week	Excellent	Good	Good	5.5	Nil
17.Rajendran 30727	50/m	Type 3	4 days	Fair	Poor	Fair	16.5	Nil
18.Mr.Sundaram 30728	42/m	Type 4	1 week	Good	Poor	Poor	19.25	Nil
19.Mrs.Sumathi 83467	46/f	Type 1	3 days	Excellent	Excellent	Good	5.5	Nil
20.Mr.Jaganthan 70150	58/m	Type 8	2 weeks	Good	Fair	Fair	13.75	Deformity and pin tract infection

Thesis Proforma

Name :

Age/Sex :

IP No. :

Phone No. :

Address :

Date of Injury :

Mode of Injury :

Date of Surgery :

Post op Data Collection

Early/delayed Mobilisation :

1st follow up :

Date :

Pin Sites :

Radiograph :

Range of movements:

- Flexion
- Extension

2nd follow up :

Date :

Pin Sites :

Radiograph :

Range of movements:

- Flexion
- Extension
- Pronation
- Supination

Radiographic parameters

- Radial length :
- Radial Inclination :
- Palmar tilt :

3rd follow up :

Date :

Pin Sites :

Radiograph :

Range of movements:

- Flexion
- Extension

- Pronation
- Supination

Radiographic parameters

- Radial length :
- Radial Inclination :
- Palmar tilt :

DASH Scoring :

INFORMATION SHEET

Principle Investigator's Name :

Participant Name :

We are conducting **"Functional outcome analysis of fixation of distal radius fractures using 5-pin technique"** among patients attending the Institute of Orthopaedics & Traumatology, Rajiv Gandhi Government General Hospital, Chennai .

The purpose of this study is to evaluate and analyse the radiological and functional outcome of distal radius fractures fixed using 5-pin techique . We are selecting certain patients and if you are found eligible, we may use your radiographs to evaluate the outcome of the treatment which in any way do not affect your final management.

All the procedures are free of cost and there will not be any side effects.

The privacy of the patients in the research will be maintained throughout the study. In the event of any publication or presentation resulting from the research, no personally identifiable information will be shared.

Taking part in this study is voluntary. You are free to decide whether to participate in this study or to withdraw at any time; your decision will not result in any loss of benefits to which you are otherwise entitled.

The results of the special study may be intimated to you at the end of the study period or during the study if anything is found abnormal which may aid in the management or treatment.

Signature of Investigator

Signature of Participant

Date :

Place :

PATIENT CONSENT FORM

Study Detail	:	**"Functional outcome analysis of fixation of distal radius fractures using 5-pin technique"**
Study Centre	:	Rajiv Gandhi Government General Hospital, Chennai.
Patient's Name	:	
Patient's Age	:	
Identification Number	:	

Patient may check (√) these boxes

• I confirm that I have understood the purpose of procedure for the above study. I have the opportunity to ask question and all my questions and doubts have been answered to my complete satisfaction.	
• I understand that my participation in the study is voluntary and that I am free to withdraw at any time without giving reason, without my legal rights being affected.	
• I understand that sponsor of the clinical study, others working on the sponsor's behalf, the ethical committee and the regulatory authorities will not need my permission to look at my health records, both in respect of current study and any further research that may be conducted in relation to it, even if I withdraw from the study I agree to this access. However, I understand that my identity will not be revealed in any information released to third parties or published, unless as required under the law. I agree not to restrict the use of any data or results that arise from this study.	

• I agree to take part in the above study and to comply with the instructions given during the study and faithfully cooperate with the study team and to immediately inform the study staff if I suffer from any deterioration in my health or well being or any unexpected or unusual symptoms.	
• I hereby consent to participate in this study.	
• I hereby give permission to undergo detailed clinical examination, Radiographs & blood investigations as required.	

Signature/thumb impression

Patient's Name and Address:
Signature of Investigator

Investigator's Name:

Dr.Jerry Sam

ஆராய்ச்சி தகவல் தாள்

ராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு வரும் நோயாளிகளிடம் ரேடியஸ் எலும்பு முறிவினை 5-கம்பி அறுவை சிகிச்சை பயன்படுத்தி அதன் செயல்பாட்டு உத்தியின் செயல்பாட்டு விளைவு பகுப்பாய்வு குறித்த ஆராய்ச்சி நடைபெறுகிறது.

முடிவுகளை அல்லது கருத்துகளை வெளியிடும்போதோ அல்லது ஆராய்ச்சியின் போதோ தங்களது பெயரையோ அல்லது அடையாளங்களையோ வெளியிட மாட்டோம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த ஆராய்ச்சியில் பங்கேற்பது தங்களுடைய விருப்பத்தின் பேரில் தான் இருக்கிறது. மேலும் நீங்கள் எந்நேரமும் இந்த ஆராய்ச்சியிலிருந்து பின்வாங்கலாம் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

இந்த சிறப்பு சிகிச்சையின் முடிவுகளை ஆராய்ச்சியின்போது அல்லது ஆராய்ச்சியின் முடிவின் போது தங்களுக்கு அறிவிக்கப்படும் என்பதையும் தெரிவித்துக் கொள்கிறோம்.

ஆராய்ச்சியாளர் கையொப்பம் பங்கேற்பாளர் கையொப்பம்

நாள் :
இடம் :

ஆராய்ச்சி ஒப்புதல் கடிதம்

ஆராய்ச்சி தலைப்பு

ரேடியஸ் எலும்பு முறிவினை 5-கம்பி அறுவை சிகிச்சை பயன்படுத்தி அதன் செயல்பாட்டு உத்தியின் செயல்பாட்டு விளைவு பகுப்பாய்வு

ராஜீவ் காந்தி அரசு பொது மருத்துவமனைக்கு வரும் நோயாளிகளிடம் ரேடியஸ் எலும்பு முறிவினை 5-கம்பி அறுவை சிகிச்சை பயன்படுத்தி அதன் செயல்பாட்டு உத்தியின் செயல்பாட்டு விளைவு பகுப்பாய்வு குறித்த ஆராய்ச்சி நடைபெறுகிறது.

பெயர்	:	தேதி	:
வயது	:	உள் நோயாளி எண்	:
பால்	:	ஆராய்ச்சி சேர்க்கை எண்	:

இந்த ஆராய்ச்சியின் விவரங்களும் அதன் நோக்கங்களும் முழுமையாக எனக்கு தெளிவாக விளக்கப்பட்டது.

எனக்கு விளக்கப்பட்ட விஷயங்களை நான் புரிந்துகொண்டு எனது சம்மதத்தை தெரிவிக்கிறேன்.

இந்த ஆராய்ச்சியில் பிறரின் நிர்பந்தமின்றி என் சொந்த விருப்பத்தின்பேரில் பங்கு பெறுகின்றேன். இந்த ஆராய்ச்சியில் இருந்து நான் எந்நேரமும் பின்வாங்கலாம் என்பதையும் அதனால் எந்த பாதிப்பும் ஏற்படாது என்பதையும் நான் புரிந்துகொண்டேன்.

நான் இந்த ஆராய்ச்சியின் விபரங்களைக் கொண்ட ஆராய்ச்சித் தகவல் தாளைப் பெற்றுக் கொண்டேன்.

இதன் மூலம் எந்த பின்விளைவும் ஏற்படாது என்று மருத்துவர் மூலம் தெரிந்து கொண்டு, நான் என்னுடைய சுய நினைவுடனும் மற்றும் முழு சுதந்திரத்துடனும் இந்த மருத்துவ ஆராய்ச்சியில் என்னை சேர்த்துக்கொள்ள சம்மதம் தெரிவிக்கிறேன்.

கையொப்பம்

INSTITUTIONAL ETHICS COMMITTEE
MADRAS MEDICAL COLLEGE, CHENNAI 600 003

EC Reg.No.ECR/270/Inst./TN/2013
Telephone No.044 25305301
Fax: 011 25363970

CERTIFICATE OF APPROVAL

To
Dr. Jerry Sam
Post Graduate in M.S.(Orthopaedics)
Madras Medical College
Chennai 600 003

Dear Dr. Jerry Sam,

The Institutional Ethics Committee has considered your request and approved your study titled **"FUNCTIONAL OUTCOME ANALYSIS OF FIXATION OF DISTAL RADIUS FRACTURES USING FIVE PIN TECHNIQUE" NO. (II) 38032016.**

The following members of Ethics Committee were present in the meeting hold on **22.03.2016** conducted at Madras Medical College, Chennai 3

1.Dr.C.Rajendran, MD.,	:Chairperson
2.Dr.R.Vimala,MD.,Dean,MMC,Ch-3	:Deputy Chairperson
3.Prof.Sudha Seshayyan,MD., Vice Principal,MMC,Ch-3	: Member Secretary
4.Prof.P.Raghumani,MS, Dept.of Surgery,RGGGH,Ch-3	: Member
5.Dr.Baby Vasumathi, Director, Inst. of O&G,Ch-8	: Member
6.Prof.M.Saraswathi,MD.,Director, Inst.of Path,MMC,Ch-3	: Member
7.Prof.Srinivasagalu,Director,Inst.of Int.Med.,MMC,Ch-3	: Member
8.Tmt.J.Rajalakshmi, JAO,MMC, Ch-3	: Lay Person
9.Thiru S.Govindasamy, BA.,BL,High Court,Chennai	: Lawyer
10.Tmt.Arnold Saulina, MA.,MSW.,	:Social Scientist

We approve the proposal to be conducted in its presented form.

The Institutional Ethics Committee expects to be informed about the progress of the study and SAE occurring in the course of the study, any changes in the protocol and patients information/informed consent and asks to be provided a copy of the final report.

Member Secretary – Ethics Committee

MEMBER SECRETARY
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FUNCTIONAL OUTCOME ANALYSIS OF FIXATION
OF DISTAL RADIUS FRACTURES USING
'FIVE PIN TECHNIQUE'

Dissertation submitted to

M.S Degree Branch-II
Orthopaedic surgery

THE TAMILNADU DR. M.G.R MEDICAL UNIVERSITY
CHENNAI-TAMILNADU
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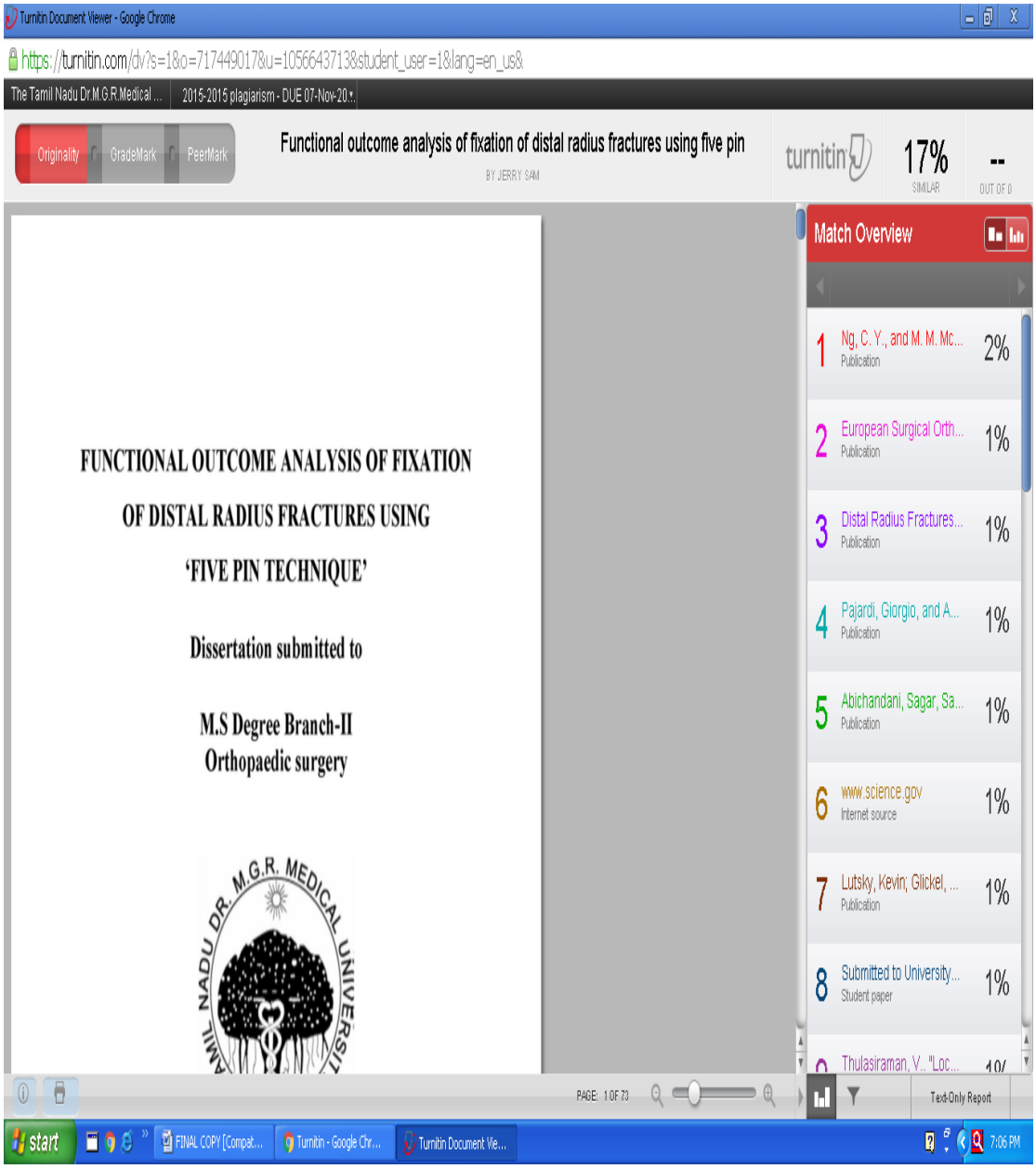
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